

OPTOELECTRONIC
PRODUCT
DATA BOOK

1995/96



OPTOELECTRONICS

Optoelectronic Product Data Book 1995/96

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ALL SPECIFICATIONS SUBJECT TO CHANGE

Printed in USA

610 North Mary Avenue
Sunnyvale, California 94086



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About QT Optoelectronics

Experience

For the last twenty five years—first as Monsanto, then General Instrument and then Quality Technologies Corporation—we have been a leading manufacturer of optoelectronic products. As a result of this experience and our leadership in developing III-V materials technology, we have contributed many firsts to the field of optoelectronics—in LED Lamps, Displays, Optocouplers and Infrared Components.

New Company Name

We have changed our name from Quality Technologies Corporation (QTC) to QT Optoelectronics. This new name reflects the fact that optoelectronics is our only business. When it comes to companies dedicated exclusively to optoelectronics, no one in the World has a bigger, broader line.

Reliable Products

At our manufacturing plant extensive reliability testing (see pg. 5) and advanced manufacturing techniques ensure the highest standards of production. We are committed to the concept of providing state-of-the-art dependable products at competitive prices.

Broad Product Range

We offer high performance optoelectronic devices in five major categories; optocouplers, I/R components, displays, lamps, and light bars and bargraph arrays. This data book contains detailed specifications on our complete line of optoelectronic products.

Product Availability

A worldwide network of stocking distributors assures immediate availability of most standard products. QT Optoelectronics authorized distributors are located worldwide. In addition, QT Optoelectronics Direct Sales Offices in the United States and International Sales Offices serving major world markets, provide a complete range of all QT Optoelectronics products. See "HOW TO ORDER" in the following section.

Efficient Service

If you have a question or a problem, just pick up the phone and call the nearest QT Optoelectronics Technical Representative. These highly qualified sales engineers can offer assistance in design and product selection. The lists on section 7 will enable you to locate one in your area.

In addition, our staff of factory product engineers can provide information, discuss specific problems and offer applications assistance. The answer to your question is only a phone call away.

You can depend on QT Optoelectronics.

About This Data Book

This data book describes in detail our complete line of optoelectronic products. For your convenience, the catalog is divided into five major product groups—optocouplers, I/R components, displays, lamps, and light bars and bargraph arrays.

A selection guide will be found at the beginning of each product section. This provides brief basic information on the product line to assist you in selecting the device best suited to your requirements.

Full specification sheets are located within each section.

For fast reference, an alphanumeric listing appears on page 19 which lists all products individually with the appropriate data sheet page number. An alphanumeric listing also appears at the beginning of each product section.

Application notes provide useful technical information to assist you in selecting and testing optoelectronic devices.

DATA SHEET CLASSIFICATIONS

CLASSIFICATION	PRODUCT STAGE	DISCLAIMERS
Preview DATA SHEET	Formative or Design	This document contains the design specifications for product under development. Specifications may be changed in any manner without notice.
Advance Information DATA SHEET	Sampling or Pre-Production	This is advance information, and specifications are subject to change without notice.
Preliminary DATA SHEET	First Production	Supplementary data may be published at a later date.

How to Order

All QT Optoelectronics products may be ordered through any of the International Sales Offices and Direct Sales Offices listed on the back cover. For immediate delivery of QT Optoelectronics products, contact any of the stocking distributors located in your area. See section 7.

Warranties

Seller warrants all items against defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment; provided, however, that Seller's liability under said warranty shall be limited, at Seller's option, to crediting Buyer's account or replacing or repairing items or parts thereof which Seller's inspection shall have disclosed to its satisfaction to have been defective in the form in which it was shipped by Seller, prior to its use in further manufacture or assembly. This warranty shall not apply to items or parts thereof that have been (a) subjected to misuse, neglect, accident, damage in transit, abuse or unusual hazard; (b) repaired, altered or modified by anyone other than Seller; or (c) used in violation of instructions furnished by Seller. All requests for return of items must receive the written authorization of Seller.

Seller's warranties extend to the Buyer and to no other person or entity.

Seller's warranties as hereinabove set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of, Seller's rendering of technical advice or service in connection with Buyer's order of the goods furnished hereunder.

THE FOREGOING ARE IN LIEU OF ALL WARRANTIES, EXPRESS, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND ANY OTHER WARRANTY OBLIGATION ON THE PART OF THE SELLER.

QT Optoelectronics Reliability

At QT Optoelectronics, product dependability is assured through an active program which includes:

New Product Qualification

All new products evolve through an orderly design-to-manufacture flow. At each stage reliability engineering is present to ensure that the defined reliability requirements are met.

The reliability plan is implemented in the development stage where actual testing begins. Stress tests are performed to show potential problem areas and the reliability of the new product is compared directly with that of a previously qualified product of a similar generic type.

During limited production, where components must meet defined reliability goals, samples from a minimum of three lots are taken for extensive testing. These samples must meet or exceed defined goals in order for the product to be considered qualified and transferred to the reliability monitoring program.

Quality Control

Quality control is a vital function at QT Optoelectronics. To minimize variations in the product and to maintain quality and hence reliability, the following in-process control activities are routinely performed:

- Incoming inspection of all piece parts and raw materials.
- Die-attach process control gate.
- Wire-bond control gate.
- Encapsulation control gate.
- 100% final testing.
- Equipment monitors.
- Final Q.A. gate of all lots.
- Finished goods stores monitor.
- Frequent process line audits for conformance to specification.

Monitor Program

To ensure that qualified products continue to meet reliability targets, a monitor program tests generic device families on a periodic basis and provides information for the reliability data bank.

Reliability monitoring consists of the following tests.*

- High Temperature Operating Life
 $T_A = 70^\circ\text{C}$ or Higher Temperature
Time=1000 hours minimum
 $I_F = \text{max. rated}$
- High Temperature Storage
 $T_A = 150^\circ\text{C}$ or specified
Time=1000 hours
- Low Temperature Storage
 $T_A = -55^\circ\text{C}$ or specified
Time=1000 hours
- 85/85 No Bias
 $T_A = 85^\circ\text{C}$
RH=85%
Time=1000 hours
- HTRB
 $T_A = 100^\circ\text{C}$ or specified
Voltage=80% max. rated
Time=1000 hours
- Thermal Shock per MIL-STD-883C, Method 1011
 $T_A = 0^\circ\text{C}$ to 100°C (Air to Air)
No. of cycles=30
- Temperature Cycle per MIL-STD-883C, Method 1010
 $T_A = \text{per device based on storage temperature (Air to Air)}$
No. of cycles=50
- Pressure Pot pressure=15 PSI
Time=96 hours
 $T_A = 121^\circ\text{C} \pm 1^\circ\text{C}$
- 85/85 and Pressure Pot tests are not required per MIL-STD-883C for Hermetic Products.
- Solder Heat Tests (visible products only) per MIL-STD-883C Method 2003.3
 $T_A = 260^\circ\text{C} \pm 5^\circ\text{C}$
Duration 10 sec.

Reliability Test Facilities

The Kuala Lumpur (Malaysia) test facility is equipped with:

- Automated Testing.
- Life test equipment—High and Low Temperature.
- Temperature/humidity chambers.
- High Temperature ovens.
- T/S and T/C equipment.

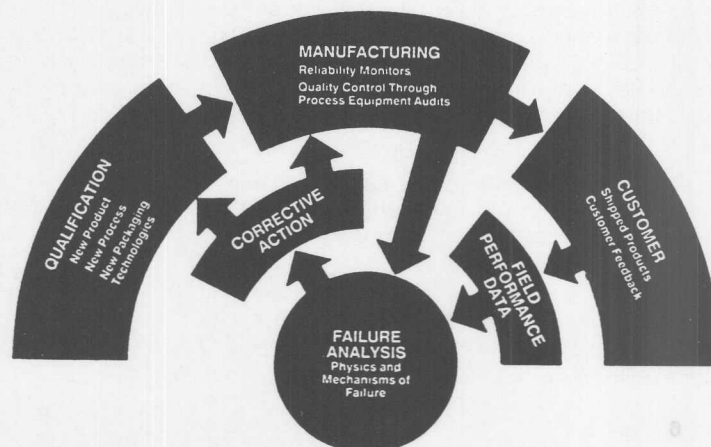
In addition, the failure analysis lab facilities have the following capabilities:

- Electrical testing and verification.
- Pin-to-pin measurements.
- Package dissection and cross-sectioning.
- Chemical etching.
- Optical photomicroscopy.
- Micromanipulators.
- Access to scanning electron microscope with X-ray spectrometry.
- Access to Augur analysis.

Failure Analysis and Qualitative Reliability

When a reliability failure does occur, a detailed analysis is performed to provide data for corrective action, as well as guidelines for the design of future new products.

This on-going activity and the resulting feedback and action are illustrated in the accompanying diagram.



*Not all tests apply to all products.

Monitor Program

To ensure that qualified products continue to meet reliability targets, a monitor program tests generic device families on a periodic basis and provides information for the reliability data bank.

- Frequent process line audits for conformance to specification.
- Finished goods stores monitor.
- Final O.A. gate of all lots.
- Equipment monitors.
- 100% final testing.
- Encapsulation control gate.
- Wire-bond control gate.
- Die-attach process control gate.
- Parts and raw materials.
- Incoming inspection of all pieces performed:

Quality Control

Quality control is a vital function at QT Optoelectronics to minimize variations in the product and to maintain quality and hence reliability; the following in-process control activities are routinely performed:

■ Incoming inspection of all pieces parts and raw materials.

■ Die-attach process control gate.

■ Wire-bond control gate.

■ Encapsulation control gate.

■ 100% final testing.

■ Equipment monitors.

■ Final O.A. gate of all lots.

■ Finished goods stores monitor.

■ Frequent process line audits for conformance to specification.

New Product Qualification

All new products evolve through an orderly design-to-manufacture flow. At each stage reliability engineering is present to ensure that the defined reliability requirements are met. The reliability plan is implemented in the development stage where actual testing begins. Stress tests are performed to show potential problem areas and the reliability of the new product is compared directly with that of a previously qualified product of a similar generic type.

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- High Temperature Operating Life $T_A = 70^\circ\text{C}$ or Higher Temperature Time = 1000 hours minimum $I_F = \text{max. rated}$
 - High Temperature Storage $T_A = 150^\circ\text{C}$ or specified Time = 1000 hours
 - Low Temperature Storage $T_A = -55^\circ\text{C}$ or specified Time = 1000 hours
 - 85/85 No Bias $T_A = 85^\circ\text{C}$ RH = 85% Time = 1000 hours
 - HTBB $T_A = 100^\circ\text{C}$ or specified Voltage = 80% max. rated Time = 1000 hours
 - Thermal Shock per MIL-STD-883C, Method 1011 $T_A = 0^\circ\text{C}$ to 100°C (Air to Air) No. of cycles = 30
 - Temperature Cycle per MIL-STD-883C, Method 1010 $T_A = \text{per device based on storage temperature (Air to Air)}$ No. of cycles = 50
 - Pressure Pot pressure = 15 PSI Time = 96 hours $T_A = 121^\circ\text{C} \pm 1^\circ\text{C}$
 - 85/85 and Pressure Pot tests are not required per MIL-STD-883C for Hermetic Products.
 - Solder Heat Tests (visible products only) per MIL-STD-883C Method 2003 $T = 260^\circ\text{C} \pm 5^\circ\text{C}$ Duration 10 sec.

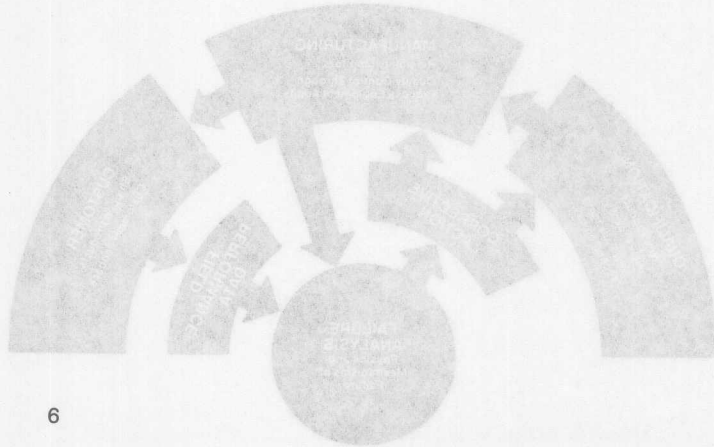
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- Electrical testing and verification.
 - Pin-to-pin measurements.
 - Package dissection and cross-sectioning.
 - Chemical etching.
 - Optical photomicroscopy.
 - Micromanipulators.
 - Access to scanning electron microscope with X-ray spectrometry.
 - Access to Auger analysis.

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*Not all tests apply to all products.

OPTOPLANAR™

QT OPTOELECTRONICS' PROCESS TECHNOLOGY

QT OPTOELECTRONICS has developed a new high voltage optocoupler packaging technology which the company has termed OPTOPLANAR™. The name derives from the coplanarity which is a primary feature of the new technology, i.e., placing the emitter, detector and, in some cases, the driver, on the same plane. This does away with leadframe folding or flipping, operations which are both difficult to control and a potential source of problems.

Benefits of the OPTOPLANAR™ process include:

- Increased coupling efficiency
- Higher tolerance to changes in die position
- Less dependence on size of sensitive area on detector
- Reduction in assembly-related CTR variations
- Enhanced reliability
- Improved performance consistency

The improvements in features and performance represented by the new technology are so marked that QT OPTOELECTRONICS plans to implement the OPTOPLANAR™ process across its entire optocoupler product line.

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The improvements in features and performance represented by the new technology are so marked that QT OPTOELECTRONICS plans to implement the OPTOPLANAR™ process across its entire optocoupler product line.

FORMER PHILIPS OPTOCOUPLER PRODUCTS

In addition to the optocouplers listed in sections 1 and 2, QT Optoelectronics also supplies the optocouplers formerly manufactured by Philips Semiconductor. The following part numbers are available. All devices are available with UL and VDE approval. Please contact your nearest QT Optoelectronics sales representative for more details.

4N29
4N30
4N31
4N38
CNG35
CNG36
CNG40
CNG82
CNG83
CNW11AV-1
CNW11AV-2
CNW11AV-3
CNW82
CNW83
CNW84
CNW85
CNW135
CNW136
CNW137
CNW138
CNW139

CNW2601
CNW2611
CNW4502
CNX35U
CNX36U
CNX38U
CNX39U
CNX48U
CNX62A
CNX71A
CNX72A
CNX82A
CNX83A
CNY17F-4
CNY17G-1
CNY17G-2
CNY17G-3
CNY17G-4
CNY17GF-1
CNY17GF-2
CNY17GF-3

CNY17GF-4
H11B255
H11D4
H11G3
PO40
PO44A
SL5500
SL5501
SL5504
SL5505S
SL5511
SL5582
SL5582W
SL5583
SL5583W

FORMER PHILIPS OPTOCOUPLER PRODUCTS

In addition to the optocouplers listed in sections 1 and 2, OT Optoelectronics also supplies the optocouplers formerly manufactured by Philips Semiconductor. The following part numbers are available. All devices are available with UL and VDE approval. Please contact your nearest OT Optoelectronics sales representative for more details.

4N29	CNW5601	CNY17GF-4
4N30	CNW5611	H11B25
4N31	CNW4505	H11D4
4N38	CNX35U	H11G3
CNG35	CNX36U	PO40
CNG36	CNX38U	PO4A
CNG40	CNX39U	SL5500
CNG82	CNX48U	SL5501
CNG83	CNX62A	SL5504
CNW11AV-1	CNX71A	SL5505
CNW11AV-2	CNX72A	SL5511
CNW11AV-3	CNX82A	SL5582
CNW82	CNX83A	SL5583W
CNW83	CNY17F-4	SL5583
CNW84	CNY17G-1	SL5583W
CNW85	CNY17G-2	
CNW135	CNY17G-3	
CNW136	CNY17G-4	
CNW137	CNY17GF-1	
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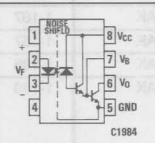
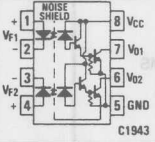
OPTOCOUPLEDERS HIGH SPEED

FAN-IN/FAN-OUT AND CTR AT 0-70°C; ALL WITHSTAND TEST VOLTAGES ARE 2500 VAC RMS 1 MIN.

EQUIVALENT CIRCUIT	PART NUMBER	INPUT	OUTPUT	V _{CC} /V _{CCO} OR BV _{CEO}	FAN-IN/FAN-OUT OR CTR MIN. @ I _F =mA	DATA RATE (NRZ) TYP.	CMR TYP.	PAGE	COMMENT
	74OL6000	Logic 1 LS TTL Load	Logic 10 TTL Loads Totem Pole	5 V/5 V	0.4 mA/16 mA	15 Mbit/s	15 kV/μs	1-57	Buffer
	74OL6001	Logic 1 LS TTL Load	Logic 10 TTL Loads Totem Pole	5 V/5 V	0.4 mA/16 mA	15 Mbit/s	15 kV/μs	1-57	Inverter
	74OL6010	Logic 1 LS TTL Load	Logic 10 TTL Loads Open Coll.	5 V/5-15 V	0.4 mA/16 mA	8 Mbit/s	15 kV/μs	1-57	Buffer
	74OL6011	Logic 1 LS TTL Load	Logic 10 TTL Loads Open Coll.	5 V/5-15 V	0.4 mA/16 mA	8 Mbit/s	15 kV/μs	1-57	Inverter
	6N137 HCPL-2601 HCPL-2611	LED	Logic 8 TTL Loads Open Coll.	-5V	5 mA/13 mA Recommended I _F =6.3 mA	10 Mbit/s	10 kV/μs	1-45 1-45 1-45	
	HCPL-2630 HCPL-2631	Dual LED	Dual Logic 8 TTL Loads Open Coll.	-5V	5 mA/13 mA Recommended I _F =6.3 mA	10 Mbit/s	10 kV/μs	1-101 1-101	
	HCPL-4502 6N136 ¹ HCPL-2503 6N135	LED	Transistor	to 30 V to 15 V to 30 V to 15 V	14% @ 8 mA 17% @ 16 mA 15% @ 16 mA 9% @ 16 mA 5% @ 16 mA	1 Mbit/s 1 Mbit/s 1 Mbit/s 1 Mbit/s	10 kV/μs 10 kV/μs 10 kV/μs 10 kV/μs	1-39 1-39 1-39 1-39	Guaranteed Switch Times 0-70°C Recommended I _F is 20% Above Rated I _F
	HCPL-2531 HCPL-2530	Dual LED	Dual Transistor	to 30 V to 30 V	15% @ 16 mA 5% @ 16 mA	1 Mbit/s 1 Mbit/s	10 kV/μs 10 kV/μs	1-95 1-95	Recommended I _F is 20% Above Rated I _F

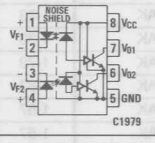
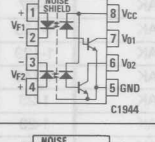
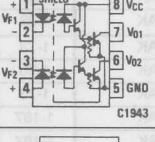
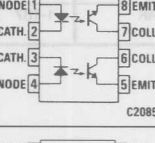
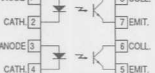
OPTOCOUPLEDERS HIGH SPEED

**FAN-IN/FAN-OUT AND CTR AT 0-70°C; ALL WITHSTAND TEST VOLTAGES ARE 2500 VAC RMS 1 MIN.
(Cont'd)**

EQUIVALENT CIRCUIT	PART NUMBER	INPUT	OUTPUT	V_{CC}/V_{CCO} OR BV_{CEO}	FAN-IN/FAN-OUT OR CTR MIN. @ $I_F = \text{mA}$	DATA RATE (NRZ) TYP.	CMR TYP.	PAGE	COMMENT
	6N139	LED	Darlington	to 18 V	400% @ 0.5 mA 500% @ 1.6 mA	100 kbit/s	10 kV/μs	1-51	Low $V_{CE(SAT)}$ of 0.4 V Recommended I_F is 20% Above Rated I_F
	6N138	LED	Darlington	to 7 V	300% @ 1.6 mA	100 kbit/s	10 kV/μs	1-51	
	HCPL-2731	LED	Darlington	to 18 V	400% @ 0.5 mA 500% @ 1.6 mA	100 kbit/s	10 kV/μs	1-107	Recommended I_F is 20% Above Rated I_F
	HCPL-2730	LED	Darlington	to 7 V	300% @ 1.6 mA	100 kbit/s	10 kV/μs	1-107	

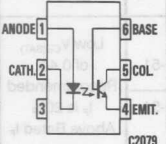
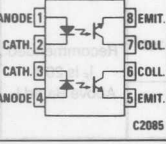
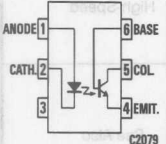
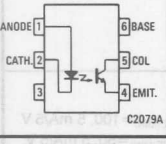
OPTOCOUPLEDERS DUALS

ALL WITHSTAND TEST VOLTAGE 2500 VAC RMS 1 MIN.

EQUIVALENT CIRCUIT	PART NUMBER	OUTPUT	V_{CC} OR BV_{CEO}	$CTR_{CE(SAT)}$ MIN. @ $I_F = \text{mA}$ or F_I/F_O	DATA RATE (NRZ) TYP.	CMR TYP.	PAGE	COMMENT
	HCPL-2630 HCPL-2631	Logic	5 V	5 mA/13 mA	10 Mbit/s	10 kV/μs	1-101 1-101	See Also High-Speed
	HCPL-2530 HCPL-2531	Transistor	to 30 V	5% @ 16 mA 15% @ 16 mA	1 Mbit/s 1 Mbit/s	10 kV/μs 10 kV/μs	1-95 1-95	See Also High-Speed
	HCPL-2730 HCPL-2731	Split Darlington	to 7 V to 18 V	300% @ 1.6 mA 400% @ 0.5 mA 500% @ 1.6 mA	100 kbit/s 100 kbit/s	10 kV/μs 10 kV/μs	1-107 1-107	
	MCT62 MCT61 MCT6	Transistor	30 V	12.5% @ 16 mA 12.5% @ 16 mA 12.5% @ 16 mA	15 kbit/s 10 kbit/s 1 kbit/s		1-173 1-173 1-173	$CTR_{CE(MIN)} = 100, 5 \text{ mA/5 V}$ $CTR_{CE(MIN)} = 50, 5 \text{ mA/5 V}$ Low Cost
	MCT9001	Transistor	30 V	50% @ 5 mA			1-177	

OPTOCOUPPLERS TRANSISTOR-OUTPUT LOW SPEED

LISTED BY INCREASING I_F AND DECREASING $CTR_{CE(SAT)}$

EQUIVALENT CIRCUIT	PART NUMBER	$CTR_{CE(SAT)}$ MIN.		CTR_{CE} MIN. @ $V_{CE} \geq 5V$ @ $I_F =$		CTR_{CB} MIN. = mA	BV_{CEO} MIN. VOLT.	CMR TYP.	WITHSTAND TEST VOLTAGE	PAGE
		@ $I_F =$	mA	@ $I_F =$	mA					
 C2079	MCT5211	75%	1.0	110%	1	0.25%	30	5 kV/ μ S	7500 VAC PEAK	1-167
	MCT5211	100%	1.6	150%	1.6	0.3 %	30	5 kV/ μ S	7500 VAC PEAK	1-167
	MCT5210	60%	3.0	70%	3.0	0.2 %	30	5 kV/ μ S	7500 VAC PEAK	1-167
	MCT210	50%	3.2	150%	10	—	30	—	7500 VAC PEAK	1-135
	MCT5201	120%	5.0	TYP 300%	5.0	0.28%	30	5 kV/ μ S	7500 VAC PEAK	1-159
 C2085	(MCT6)	See Duals							2500 VAC RMS	
 C2079	MCT5200	75%	10	TYP 200%	10	0.2%	30	5 kV/ μ S	7500 VAC PEAK	1-159
	MCT2200	25%	10	20%	10	—	30	—	7500 VAC PEAK	1-141
	MCT2201	25%	10	100%	10	—	30	—	7500 VAC PEAK	1-141
	MCT2202	25%	10	63-125%	10	—	30	—	7500 VAC PEAK	1-141
	CNY17-1	25%	10	40-80%	10	—	70	—	7500 VAC PEAK	1-67
	CNY17-2	25%	10	63-125%	10	—	70	—	7500 VAC PEAK	1-67
	CNY17-3	25%	10	100-200%	10	—	70	—	7500 VAC PEAK	1-67
	CNY17-4	25%	10	160-320%	10	—	70	—	7500 VAC PEAK	1-67
	MCT270	20%	10	50%	10	—	30	—	7500 VAC PEAK	1-145
	4N35	20%	10	340%	10	—	30	—	7500 VAC PEAK	1-33
	4N36	20%	10	340%	10	—	30	—	7500 VAC PEAK	1-33
	4N37	20%	10	340%	10	—	30	—	7500 VAC PEAK	1-33
	H11A1	5%	10	50%	10	—	30	—	7500 VAC PEAK	1-79
	H11AA1, 2, 3, 4 See AC-Input								7500 VAC PEAK	1-83
	H11D1 ²	5%	10	20%	10	—	300	—	7500 VAC PEAK	1-87
	H11D2 ²	5%	10	20%	10	—	300	—	7500 VAC PEAK	1-87
	H11D ²	5%	10	20%	10	—	200	—	7500 VAC PEAK	1-87
	MCT2	12.5%	16	20%	10	—	30	—	7500 VAC PEAK	1-123
	MCT2E	12.5%	16	20%	10	—	30	—	7500 VAC PEAK	1-129
 C2079A	MCT271	12.5%	16	45-90%	10	—	30	—	7500 VAC PEAK	1-149
	4N25	4%	50	20%	10	—	30	—	7500 VAC PEAK	1-23
	4N26	4%	50	20%	10	—	30	—	7500 VAC PEAK	1-23
	4N27	4%	50	10%	10	—	30	—	7500 VAC PEAK	1-23
	4N28	4%	50	10%	10	—	30	—	7500 VAC PEAK	1-23
	CNY17F-1	25%	10	40-80%	10	—	70	—	7500 VAC PEAK	1-73
	CNY17F-2	25%	10	63-125%	10	—	70	—	7500 VAC PEAK	1-73
	CNY17F-3	25%	10	100-200%	10	—	70	—	7500 VAC PEAK	1-73
	MOC8111	25%	10	40%	10	—	70	—	7500 VAC PEAK	1-187
	MOC8112	25%	10	63%	10	—	70	—	7500 VAC PEAK	1-187
	MOC8113	25%	10	100%	10	—	70	—	7500 VAC PEAK	1-187

¹Guaranteed Switching Times Over 0-70°C

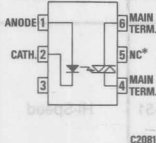
²High Volt

³At $T_A = -55$ to $+100^\circ\text{C}$

⁴To order VDE device, add .300 suffix to part number

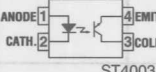
⁵VDE qualification pending, Call QT.

OPTOCOUPPLERS NON-ZERO-CROSS TRIACS

EQUIVALENT CIRCUIT	PART NUMBER	I_{FT} MAX.	V_{DRM} MIN.	WITHSTAND TEST VOLTAGE	PAGE
	MCP3022	10 mA	400 V	7500 VAC PEAK	1-119
	MCP3021	15 mA	400 V		1-119
	MCP3020	30 mA	400 V		1-119
	MCP3011	10 mA	250 V		1-113
	MCP3010	15 mA	250 V		1-113
	MCP3009	30 mA	250 V		1-113

*To Order VDE Device, Add .300 Suffix To Part Number

OPTOCOUPPLERS TRANSISTOR OUTPUT TO-18 PACKAGE

EQUIVALENT CIRCUIT	PART NUMBER	$CTR_{CE(SAT)}$ MIN. @ $I_F =$		CTR_{CE} MIN. @ $V_{CE} = 10V$ @ $I_F =$		V_{CE0} MIN. VOLT.	WITHSTAND TEST VOLTAGE	PAGE
			mA		mA			
	MCT4	5%	10	15%	10	30	1000 VDC	1-153
	MCT4	4%	50	—	—	30		1-153
	MCT4R ^s	5%	10	15%	10	30		1-157
	MCT4R ^s	4%	50	—	—	30		1-157

^sTested to MIL-STD-883 Class B

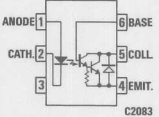
OPTOCOUPERS DARLINGTON-OUTPUT

LISTED BY INCREASING I_E AND DECREASING $CTR_{CE(SAT)}$ MIN.

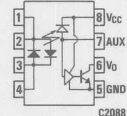
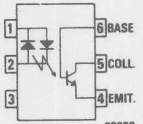
EQUIVALENT CIRCUIT	PART NUMBER	CTR _{CE(SAT)} MIN.			CTR _{CE} MIN.		BV _{CEO} MIN. VOLT.	CMR TYP.	WITHSTAND TEST VOLTAGE	PAGE	COMMENTS
		@ I _F =	mA	V _{CE(SAT)}	@ I _F =	mA					
	6N139	400%	0.5	0.4 V	—	—	18	10 kV/μs	2500 VAC RMS	1-51	Hi-Speed
	HCPL-2731	400%	0.5	0.4 V	See: Duals			10 kV/μs	2500 VAC RMS	1-107	Hi-Speed
	6N138	300%	1.6	0.4 V	—	—	7	10 kV/μs	2500 VAC RMS	1-51	Hi-Speed
	4N33	25%	8.0	1.0 V	500%	10	30	—	2500 VAC RMS	1-29	
	4N32	25%	8.0	1.0 V	500%	10	30	—	2500 VAC RMS	1-29	

OPTOCOUPERS DARLINGTON-OUTPUT

LISTED BY INCREASING I_F AND DECREASING $CTR_{CE(SAT)}$ MIN. (Cont'd)

EQUIVALENT CIRCUIT	PART NUMBER	$CTR_{CE(SAT)}$ MIN.			CTR_{CE} MIN.		BV_{CEO} MIN. VOLT.	CMR TYP.	WITHSTAND TEST VOLTAGE	PAGE	COMMENTS
		@ $I_F =$	mA	$V_{CE(SAT)}$	@ $I_F =$	mA					
 C2083	H11G1	1000%	10	1.0 V	500%	1.0	100	—	7500 VAC RMS	1-91	H11G1 Hi-Volt
	H11G2	1000%	10	1.0 V	500%	1.0	80	—	7500 VAC RMS	1-91	H11G2 Hi-Volt

OPTOCOUPERS AC-INPUT LINE MONITORS

 C2088	MID400	Logic 10 TTL Loads	5 V	4 mA RMS/16 mA 0-70°C		1-181
 C2089	H11AA1 H11AA2 H11AA3 H11AA4	Transistor	30 V	10 mA/0.5 mA	20% 10% 50% 100%	1-83 1-83 1-83 1-83

UL APPROVED OPTOCOUPERS

UL LISTING - YELLOW CARD

A UL yellow card may either specify the optocoupler manufacturer's own device part number or a package code. Optocouplers are listed as a package code consisting of a single capital letter.

GENERAL

All optocouplers are always UL approved prior to introduction to the marketplace. Devices which are approved by VDE are marked "OPT 300".

UL "YELLOW CARD"

FPQU2 March 19, 1991
Component - Optical Isolators
QUALITY TECHNOLOGIES CORP
610 N MARY AVE, SUNNYVALE CA 94086

E50151 (S)

Insulation system in optical isolated switch system, Type G.

Type C.
Type D.
Type M.
Types R, R1.
Type #L.
Type S+.

All types above may be preceded by four digit data codes.

#Preceeds with 740 and system is preceded by numbers and one letter.

+ Model designation: CNY followed by two digits.

Marking: Company name and type designation.

See General Information Preceding These Recognitions.

For use only in equipment where the acceptability of the combination is determined by Underwriters Laboratories Inc.

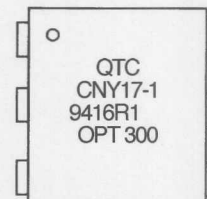
Reports: April 25, 1972; April 3, 1984; April 4, 1984; April 5, 1984; April 22, 1985; March 16, 1986; March 17, 1986.

Replaces E50151 dated March 12, 1991.

340711001

Underwriters Laboratories Inc.®

D11/0027041



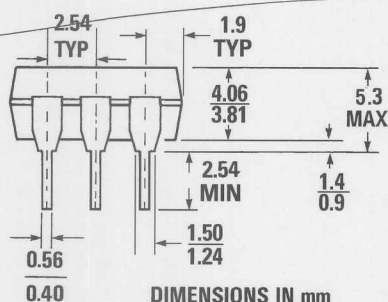
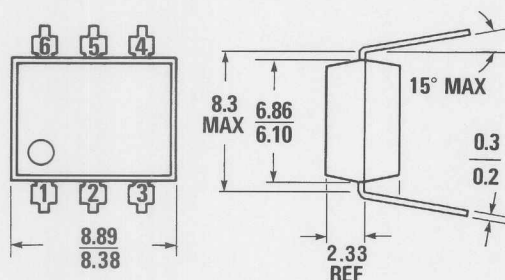
UL CODE CONVERSION TO QT PART NUMBER

*PACKAGE CODE	RATING	QT DEVICE PART NUMBER
D	2.5 kVAC RMS, 1 min.	6NXXX, MID400, HCPL-2XXX, HCPL-4XXX
G	2.5 kVAC RMS, 1 min.	4NXX, H11GX, MCT52XX, MCT2, MCT2X, MCT2XX, MCT6, MCT6X
L	2.5 kVAC RMS, 1 min.	Optologic 74OL6000, 74OL6001, 74OL6010, 74OL6011
R ₁	5.3 kVAC RMS, 5 sec.	CNY17-X, CNY17F-X, H11AX, H11DX, MCT22XX, MCP3XXX
R ₁ (with OPT 300)	5.3 kVAC RMS, 5 sec.	CNY17-X.300, CNY17F-X.300, H11A1.300, H11DX.300, MCT22XX.300, MCP302X.300

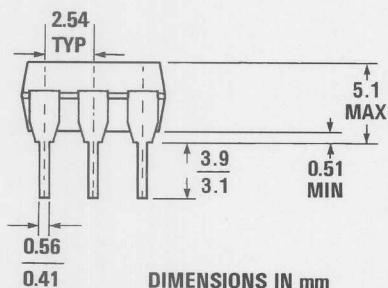
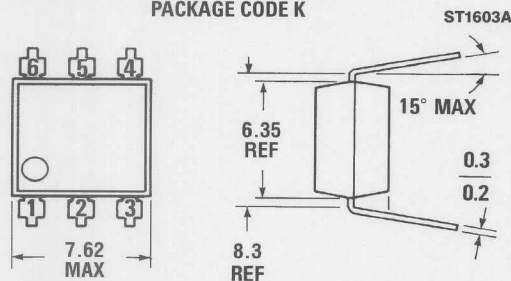
*Package codes E,F,K and N are approved under UL file #E90700. Call QTC for more information.



PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K



DIMENSIONS IN mm
PACKAGE CODE E

VDE APPROVED OPTOCOUPLEDERS

Quality Technologies' optocouplers can be supplied with approval to VDE component standard 0884/08.87.

Approved parts are denoted by an "OPT 300" marking on the device, and package code R1. When ordering VDE approved parts, add a ".300" suffix to the part number.

VDE RATINGS*

Ambient operating temperature range -55°C to $+100^{\circ}\text{C}$
Storage temperature range -55°C to $+150^{\circ}\text{C}$
Climatic test class 55/100/21
Isolation voltage (1 minute) 5300 VAC RMS
Nominal operating voltage for isolation
group C acc. to VDE DIN 0110B 500 VAC/600 VDC
Isolation creepage path 8.0 mm minimum
Isolation clearance/air path 8.0 mm minimum
Internal distance through insulation 0.5 mm minimum
Package tracking resistance index CTI 175

*Per approval certificate 76852

**ELECTRICAL MAXIMUM RATINGS
AND CHARACTERISTICS**

See standard product data sheet specifications.

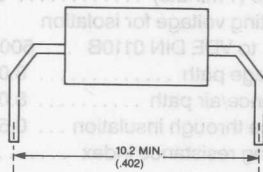
OPTION W

The VDE 0884/08.87 calls for a minimum 8.0 mm creepage distance between any point on the input terminals to any point on the output terminals of an optocoupler.

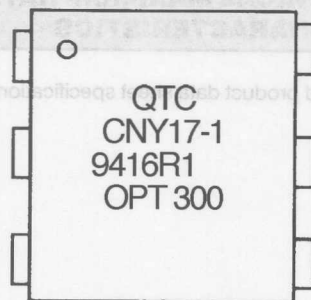
This also applies to the creepage distance over the PCB. The equipment designer may choose to break up that creepage path by stamping a slot in the PCB under the optocoupler or using leadbend Option W.

When ordering a VDE-approved optocoupler with 10 mm leadbend, add the suffix W as in MCT2200.300W. The W will not show on the optocoupler marking, but will be on the shipping tube label.

By making this option available, QTC does not assume any responsibility or liability for meeting 8.0 mm creepage distance in customer applications.



Option W Dimensions



Marking Example

CSA APPROVED COUPLERS

CSA LISTING

The Canadian Standards Association has approved Quality Technologies for Component Acceptance for all optocouplers.

The listing reference number is 82858.

The package codes for all product types is the same as those for the UL listing. (See table page 9)

GENERAL

All Quality Technologies optocouplers are included in the component acceptance listing.

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OPTO PLUS

DESCRIPTION

OPTO PLUS 2 reliability conditioning is offered for any Quality Technologies optocoupler with transistor or darlington output. This special conditioning is designed to reduce the infant mortality failures in optocouplers.

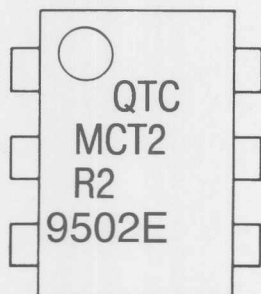
ORDER INFORMATION

To order an optocoupler with OPTO PLUS 2 add R2 to part number, i.e., MCT61R2.

RELIABILITY CONDITIONING

The following flow outlines the 100% pre-conditioning testing.

TEST PERFORMED	CONDITION
Stabilization Bake	MIL-STD-883C Method 1008.1 Condition C. 150°C, 24 hours.
Temperature Cycle	MIL-STD-883C Method 1010.2 Condition B. 5 Cycles -55°C to 125°C, 30 min. at extremes
Burn-in PLUS 2—48 hrs. (+8 -0)	MIL-STD-883C Method 1015.2 Condition C. $T_A = 70^\circ\text{C}$ $I_F = 10\text{ mA}$ $V_{CE} = 10\text{ V}$
Hot Track Testing	$T_A = 100^\circ\text{C}$ Functional Test
Final Test	$T_A = 25^\circ\text{C}$ Electrical test per specification
Outgoing Q.A.	0.065% AQL



C2093

Example of Opto Plus 2 marking

OPTO PLUS

DESCRIPTION

OPTO PLUS 2 reliability conditioning is offered for any Quality Technologies optocoupler with transistor or darlington output. This special conditioning is designed to reduce the infant mortality failures in optocouplers.

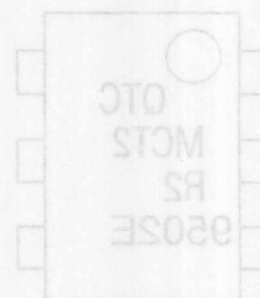
ORDER INFORMATION

To order an optocoupler with OPTO PLUS 2 add RS to part number, i.e., MCT6RS.

RELIABILITY CONDITIONING

The following flow outlines the 100% pre-conditioning testing.

TEST PERFORMED	CONDITION
Stabilization Bake	MIL-STD-883C Method 1008.1 Condition C, 150°C, 24 hours.
Temperature Cycle	MIL-STD-883C Method 1010.2 Condition B, 5 Cycles -55°C to 125°C, 30 min. at extremes
Burn-in PLUS 2 - 48 hrs. (+8) (-0)	MIL-STD-883C Method 1015.2 Condition C, $T_A = 10^\circ\text{C}$ $I_F = 10\text{ mA}$ $V_F = 10\text{ V}$
Hot Track Testing	$T_A = 100^\circ\text{C}$ Functional Test
Final Test	$T_A = 25^\circ\text{C}$ Electrical test per specification
Outgoing Q.A.	0.055% AQL

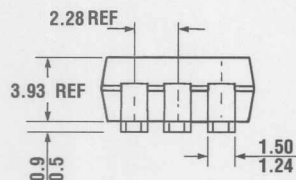
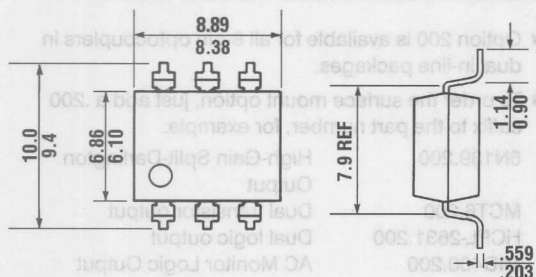


CS083

Example of Opto Plus 2 marking

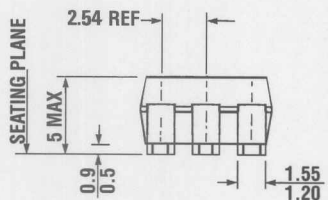
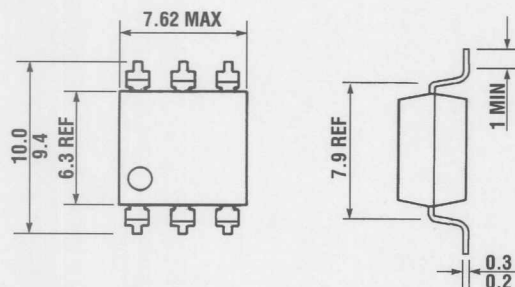
SURFACE MOUNT OPTIONS

PACKAGE DIMENSIONS



OPTION S / 6 PIN
PACKAGE CODE K

ST4001



OPTION S / 6 PIN
PACKAGE CODE E

ST4002

FEATURES

OPTION S

- Surface Mount Options available for all Quality Technologies 6 pin dual in-line optocouplers.
- Industry Standard lead co-planarity — within 0.1 mm/.004 inch.
- Compatible with vapor phase reflow soldering — withstands standard 215°C/30 second process.
- Electrical specifications unchanged - see applicable device data sheets.
- Uncompromised isolation performance.
- UL approved - File E90700.

ORDER INFORMATION

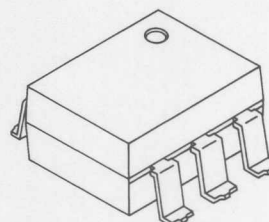
Option S is available for all 6-pin optocouplers in plastic packages.

To order the surface mount option, just add a .S suffix to the part number, for example:

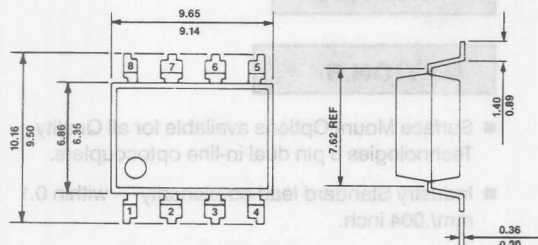
740L6000.S	OPTOLOGIC
H11G2.S	High Voltage Transistor Output
CNY17F-1.S	Single Transistor Output
MCT2.S	Single Transistor Output

OPTION S

- Formed leads for JEDEC MS-013 surface mount specification compatibility.



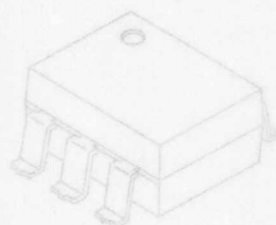
PACKAGE DIMENSIONS



ST19-06

DIMENSIONS IN mm

Option 200 / 8-Pin
PACKAGE CODE D

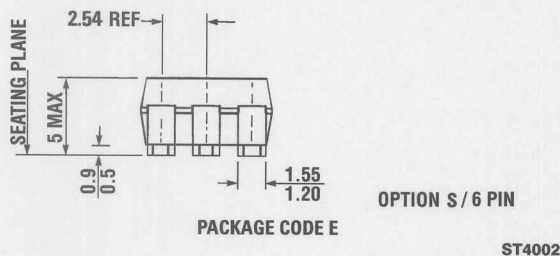
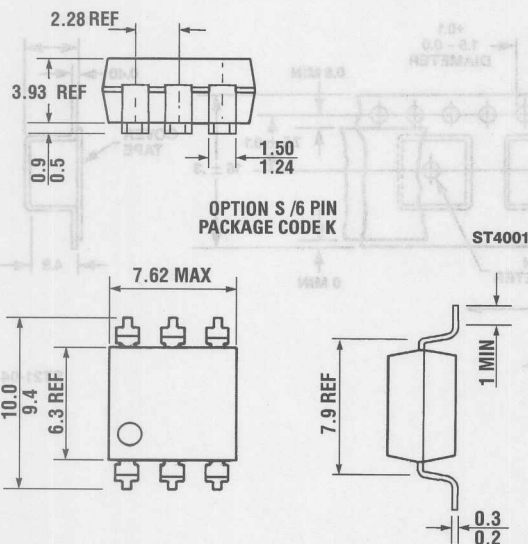
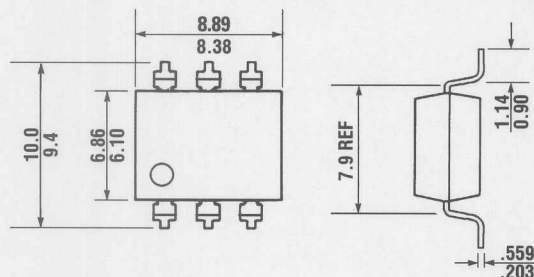


ORDERING INFORMATION

- Option 200 is available for all 8-pin optocouplers in dual in-line packages.
- To order the surface mount option, just add a .200 suffix to the part number, for example:
6N139.200 High-Gain Split-Darlington Output
MCT6.200 Dual transistor output
HCPL-2631.200 Dual logic output
MID400.200 AC Monitor Logic Output

TAPE AND REEL

PACKAGE DIMENSIONS (OPTION S)



FEATURES

- Taping of Surface-Mount optocouplers for compatibility with automatic placement equipment
- Packaging in full compliance with EIA Standard 481-A—Option S
- Efficient packaging, static-inhibiting materials, industry compatible tape
- Bar coding label for optimum inventory control

ORDERING INFORMATION

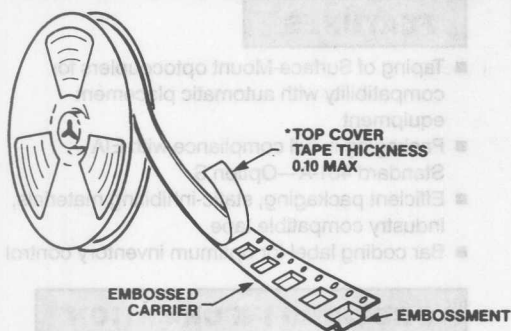
To order 6-pin package on Tape and Reel, include appropriate standard device part number, option, and suffix code to specify Tape and Reel. Standard quantity per reel is 1000 parts.

For example:

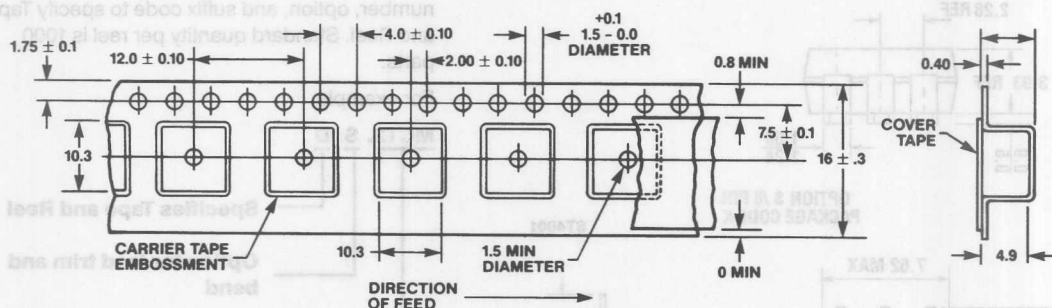
MCT2. S D

- Specifies Tape and Reel**
- Option for lead trim and bend**
- Standard part number for 6-pin optocoupler**

PACKAGE DIMENSIONS (OPTION S)



ST20-03

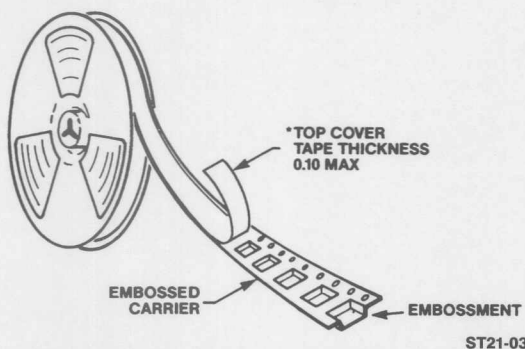
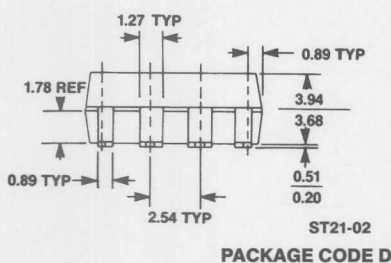
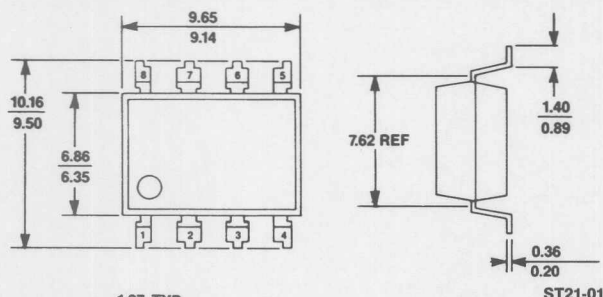


ALL DIMENSIONS ARE IN mm.
ALL DIMENSIONS AND TOLERANCES PER E.I.A. STANDARD 481-A.

ST21-04

TAPE AND REEL

PACKAGE DIMENSIONS (OPTION 200)



FEATURES

- Taping of Surface-Mount optocouplers for compatibility with automatic placement equipment
- Packaging in full compliance with EIA Standard 481-A—200
- Efficient packaging, static-inhibiting materials, industry compatible tape
- Bar coding label for optimum inventory control

ORDERING INFORMATION

To order 8-pin package on Tape and Reel, include appropriate standard device part number, option, and suffix code to specify Tape and Reel. Standard quantity per reel is 1000 parts.

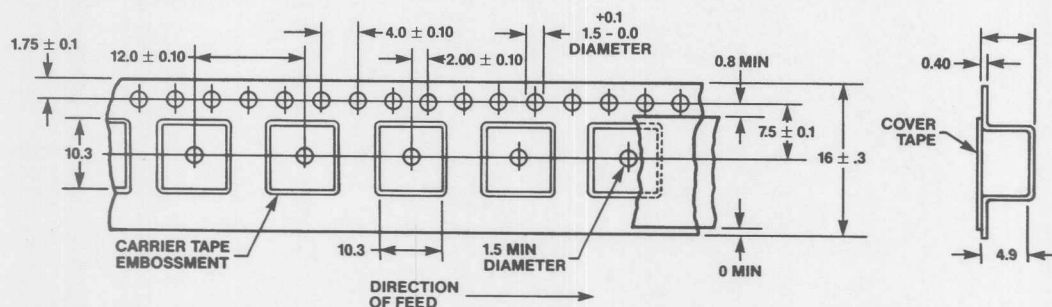
For example:

MCT9001.200 D

Specifies Tape and Reel

Option for lead trim and bend

Standard part number for 8-pin optocoupler



ALL DIMENSIONS ARE IN mm.
ALL DIMENSIONS AND TOLERANCES PER E.I.A. STANDARD 481-A.

FEATURES

- Taping of Surface Mount optocouplers for compatibility with automatic placement equipment
- Packaging in full compliance with EIA Standard 481-A-200
- Efficient packaging, static-inhibiting materials, industry compatible tape
- Bar coding label for optimum inventory control

ORDERING AND LABELING

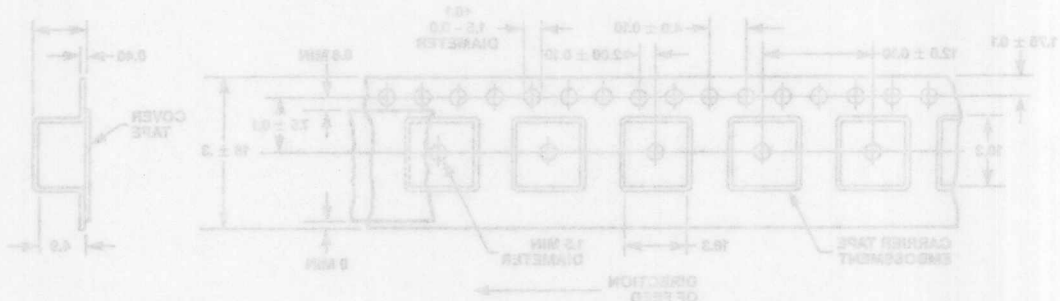
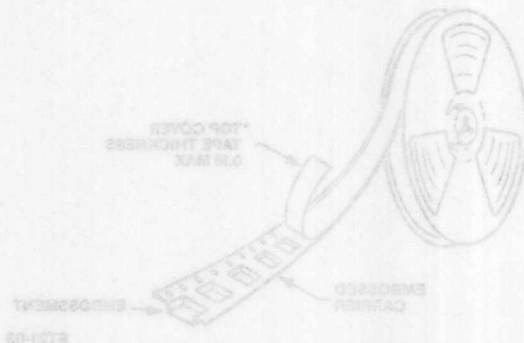
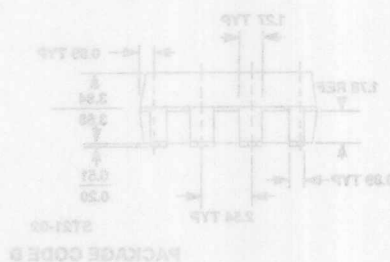
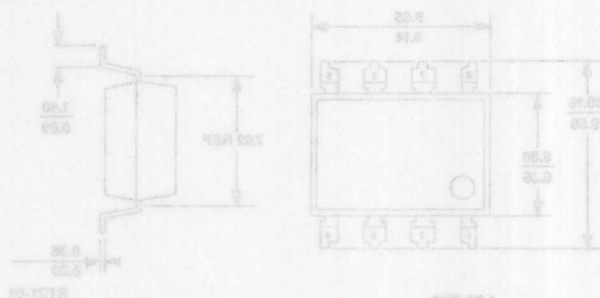
To order 8-pin package on Tape and Reel, include appropriate standard device part number, option, and suffix code to specify Tape and Reel. Standard quantity per reel is 1000 parts.

For example:

MC18001300 D

8-pin optocoupler
Standard part number for
band
Option for lead trim and
Specify Tape and Reel

PACKAGING DIMENSIONS

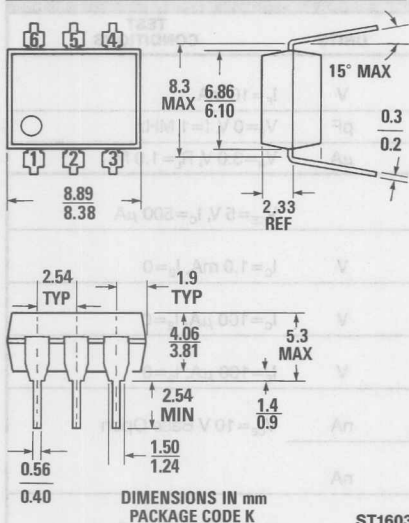


ALL DIMENSIONS ARE IN MM.
ALL DIMENSIONS AND TOLERANCES PER EIA STANDARD 481-A

8231-02

4N25 4N27
4N26 4N28

PACKAGE DIMENSIONS

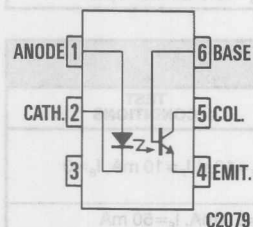


DESCRIPTION

The 4N25, 4N26, 4N27, and 4N28 series of optocouplers have an NPN silicon planar phototransistor optically coupled to a gallium arsenide diode.

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- Small package size and low cost
- Excellent frequency response
- UL recognized—File E90700



Equivalent Circuit

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

- *Storage temperature -55°C to 150°C
- *Operating temperature at junction -55°C to 100°C
- *Lead temperature (soldering, 10 sec) 260°C
- *Total package power dissipation at 25°C ambient (LED plus detector) 250 mW
- *Derate linearly from 25°C 3.3 mW/°C

INPUT DIODE

- *Forward DC current continuous 80 mA
- *Reverse voltage 3.0 V
- *Peak forward current (300 μs, 2% duty cycle) 3.0 A
- *Power dissipation at 25°C ambient 150 mW
- *Derate linearly from 25°C 2.0 mW/°C

OUTPUT TRANSISTOR

- *Collector emitter voltage (BV_{CEO}) 30 V
- *Collector base voltage (BV_{CBO}) 70 V
- *Emitter collector voltage (BV_{ECO}) 7 V
- *Power dissipation at 25°C ambient 150 mW
- *Derate linearly from 25°C 2.0 mW/°C

*Indicates JEDEC Registered Data.

4N25 4N26 4N27 4N28

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
*Forward voltage	V_F		1.20	1.50	V	$I_F = 10 \text{ mA}$
Capacitance	C		150		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
*Reverse leakage current			.05	100	μA	$V_R = 3.0 \text{ V}, R_L = 1.0 \text{ M}\Omega$
DETECTOR						
DC forward current gain	h_{FE}		250			$V_{CE} = 5 \text{ V}, I_C = 500 \mu\text{A}$
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	$I_C = 1.0 \text{ mA}, I_B = 0$
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	$I_C = 100 \mu\text{A}, I_E = 0$
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	$I_E = 100 \mu\text{A}, I_B = 0$
*Collector to emitter leakage current (4N25, 4N26, 4N27)	I_{CEO}		3.5	50	nA	$V_{CE} = 10 \text{ V}$ Base Open
*Collector to emitter leakage current (4N28)				100	nA	
*Collector to base leakage current	I_{CBO}		0.1	20	nA	$V_{CB} = 10 \text{ V}$ Emitter Open

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
*Collector output current (a) (4N25, 4N26) (4N27, 4N28)	I_C	2.0 1.0	5.0 3.0	— —	mA	$V_{CE} = 10 \text{ V}, I_F = 10 \text{ mA}, I_B = 0$
*Collector-emitter saturation	$V_{CE(SAT)}$		0.2	0.5	V	$I_C = 2.0 \text{ mA}, I_F = 50 \text{ mA}$

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	TYP.	UNITS	TEST CONDITIONS
Non-saturated Collector Delay time	t_d	0.5	μs	$R_L = 100 \Omega, I_C = 2 \text{ mA}, V_{CC} = 10 \text{ V}$
Rise time	t_r	2.5	μs	(Fig. 10 and 11)
Fall time	t_f	2.6	μs	
Non-saturated Collector Delay time	t_d	2.0	μs	$R_L = 1 \text{ k}\Omega, I_C = 2 \text{ mA}, V_{CC} = 10 \text{ V}$
Rise time	t_r	15	μs	(Fig. 10 and 11)
Fall time	t_f	15	μs	

*Indicates JEDEC Registered Data.

(a) Pulse Test: Pulse Width=300 μs , Duty Cycle $\leq 2.0\%$

(b) For this test LED pins 1 and 2 are common and Phototransistor pins 4, 5 and 6 are common.

(c) If adjusted to yield $I_C = 2 \text{ mA}$ and $i_c = 0.7 \text{ mA RMS}$; Bandwidth referenced to 10 kHz.

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS (Cont'd)

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	GUAR. MAX.	UNITS	TEST CONDITIONS
Saturated t_{on} (from 5 V to 0.8 V)	t_{on} (SAT)		5		μs	$R_L=2k\Omega$, $I_F=15$ mA, $V_{CC}=5$ V
t_{off} (from SAT to 2.0 V)	t_{off} (SAT)		25		μs	$R_B=Open$ (Fig. 10)
Saturated t_{on} (from 5 V to 0.8 V)	t_{on} (SAT)		5		μs	$R_L=2k\Omega$, $I_F=20$ mA, $V_{CC}=5$ V
t_{off} (from SAT to 2.0 V)	t_{off} (SAT)		18		μs	$R_B=100k\Omega$ (Fig. 10)
Non-saturated Base—Collector photo diode Rise time	t_r		175		ns	$R_L=1k\Omega$, $V_{CB}=10$ V
Fall time	t_f		175		ns	
Isolation voltage (b) (4N25, 4N26, 4N27, 4N28)	V_{ISO}	5300	—	—	V	$I_{-0} \leq 1 \mu A$ RMS, $t=1$ minute
* (4N26, 4N27)		1500	—	—	V	Peak
* (4N28)		500	—	—	V	Peak
Isolation resistance (b)			10^{11}		Ω	$V=500$ VDC
Isolation capacitance (b)			1.3		pF	$V=0$, $f=1.0$ MHz
Bandwidth (c) (also see note 2)	B_w		300		kHz	$I_C=2.0$ mA, $R_L=100 \Omega$ (Fig. 12)

*Indicates JEDEC Registered Data.

(a) Pulse Test: Pulse Width=300 μs , Duty Cycle $\leq 2.0\%$

(b) For this test LED pins 1 and 2 are common and Phototransistor pins 4, 5 and 6 are common.

(c) If adjusted to yield $I_C=2$ mA and $i_c=0.7$ mA RMS; Bandwidth referenced to 10 kHz.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

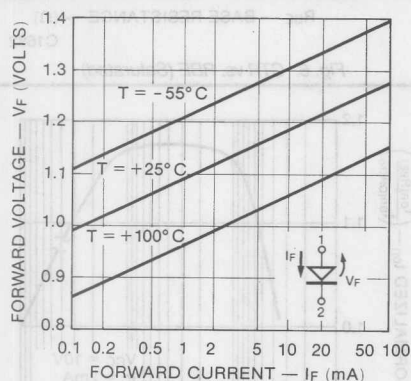


Fig. 1. Forward Voltage vs. Current

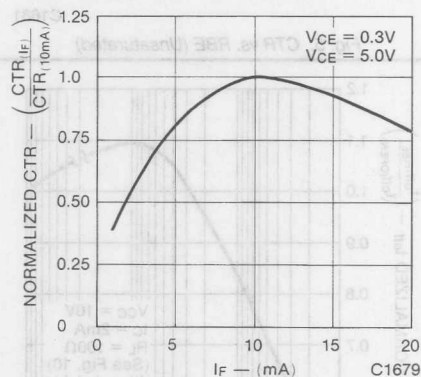


Fig. 2. Normalized CTR vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

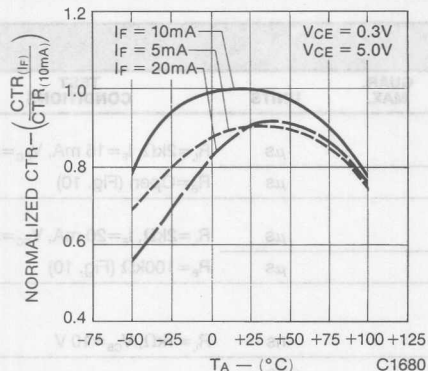


Fig. 3. Normalized CTR vs. Temperature

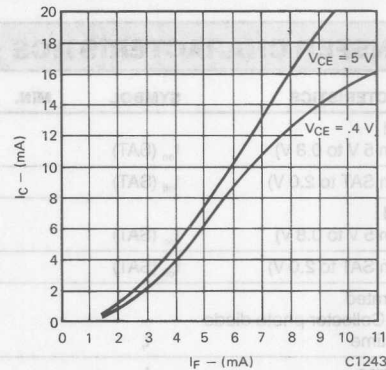


Fig. 4. Collector Current vs. Forward Current

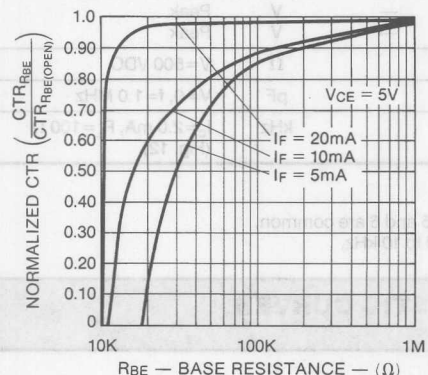


Fig. 5. CTR vs. R_{BE} (Unsaturated)

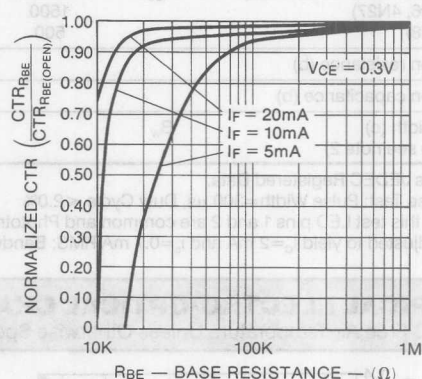


Fig. 6. CTR vs. R_{BE} (Saturated)

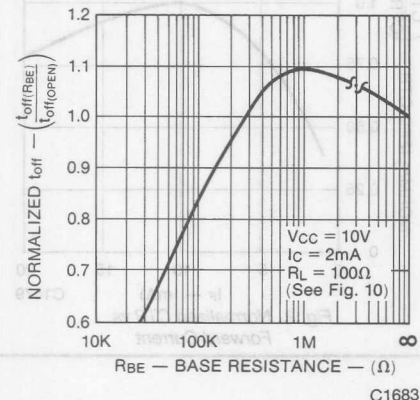


Fig. 7. Normalized T_{OFF} vs. R_{BE}

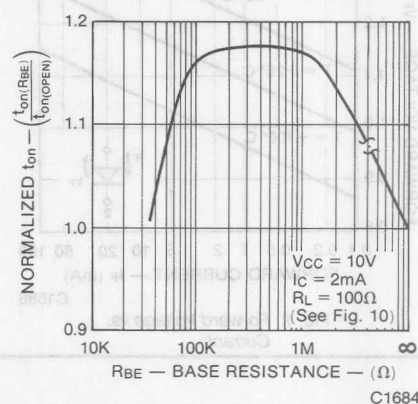
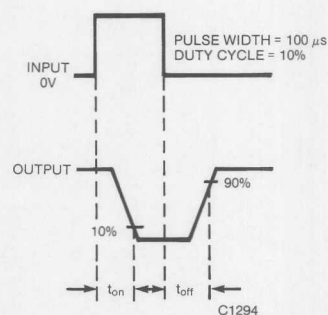
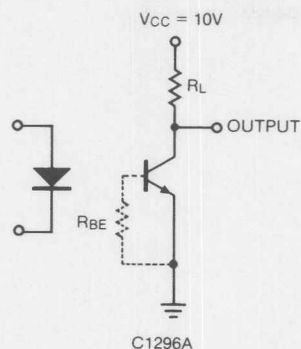
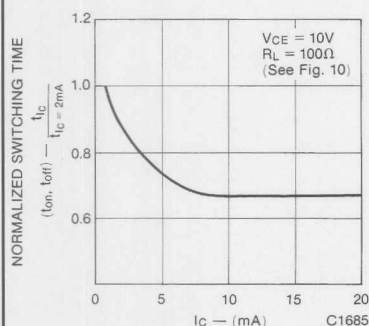


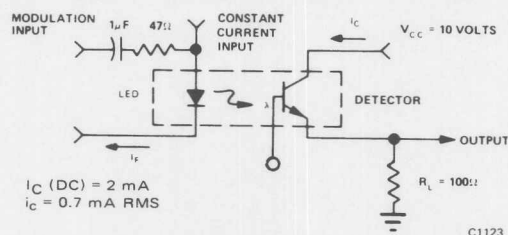
Fig. 8. Normalized T_{ON} vs. R_{BE}

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



OPERATING SCHEMATICS



NOTES

1. The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
2. The frequency at which I_C is 3dB down from the 10 kHz value.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%.
Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

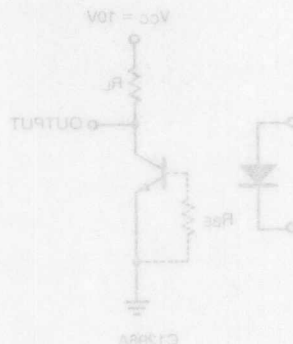
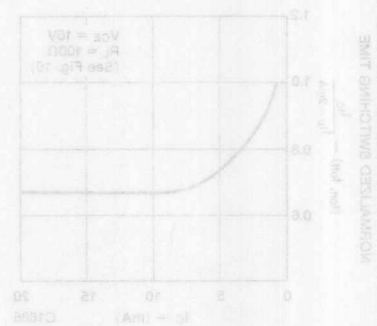
 Fig. 9. Rise and Fall Time vs. Collector Current (Typical) (Load 500 Ω)


Fig. 10. Switching Time Test Circuit

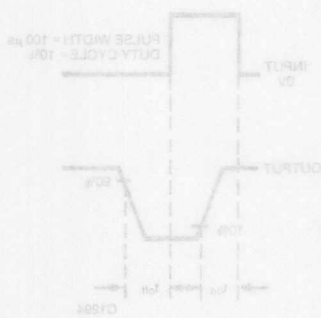


Fig. 11. Switching Time Waveforms

OPERATING SCHEMATIC

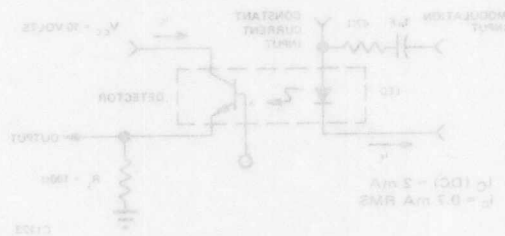


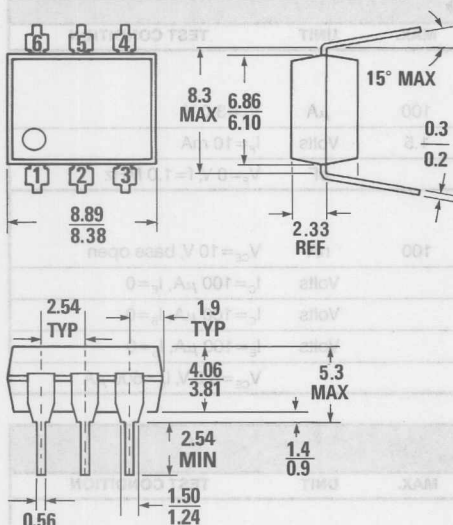
Fig. 12. Modulation Circuit Used to Obtain Output vs. Frequency Plot

NOTES

1. The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
2. The frequency at which I_C/I_F is 3dB down from the 10 kHz value.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its initial value to 90%.
4. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

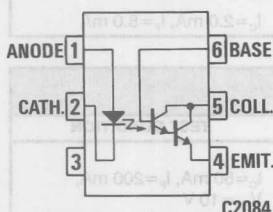
4N32 4N33

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



Equivalent Circuit

DESCRIPTION

The 4N32 and 4N33 have a gallium arsenide infrared emitter optically coupled to a silicon planar photo-darlington.

FEATURES & APPLICATIONS

- High isolation resistance— $10^{11}\Omega$
- High dielectric strength, input to output 5300 V RMS—1 minute
- Low coupling capacitance—1.0 pF
- Convenient package—plastic dual-in-line
- Long lifetime, solid state reliability
- Low weight—0.4 grams
- UL recognized—File E90700

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

TOTAL PACKAGE

*Storage temperature	−55°C to 150°C
*Operating temperature at junction	−55°C to 100°C
*Lead soldering time @ 260°C	10 seconds
*Total power dissipation at 25°C ambient	250 mW
*Derate linearly from 25°C	3.3 mW/°C

INPUT DIODE

*Power dissipation @ 25°C ambient	150 mW
*Derate linearly from 55°C	2 mW/°C
*Continuous forward current	80 mA
Reverse current	10 mA
*Peak forward current (300 μsec , 2% duty cycle)	3.0 A

*Indicated JEDEC Registered data.

OUTPUT TRANSISTOR

*Power dissipation @ 25°C ambient	150 mW
*Derate linearly from 25°C	2.0 mW/°C
*Collector-emitter breakdown voltage (BV_{CE0})	30 V
*Collector-base breakdown voltage (BV_{CBO})	50 V
Emitter-base breakdown voltage (BV_{EBO})	8.0 V
*Emitter-collector breakdown voltage (BV_{ECO})	5 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Unless Otherwise Specified)**INDIVIDUAL COMPONENT CHARACTERISTICS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
DIODE ($T_A=25^\circ\text{C}$ unless otherwise noted)						
*Reverse leakage current	I_R		0.05	100	μA	$V_R=3.0\text{ V}$
*Forward voltage	V_F		1.2	1.5	Volts	$I_F=10\text{ mA}$
Capacitance	C		150		pF	$V_F=0\text{ V}$, $f=1.0\text{ MHz}$
DETECTOR ($T_A=25^\circ\text{C}$ and $I_E=0$ unless otherwise noted)						
*Collector-emitter dark current	I_{CEO}			100	nA	$V_{CE}=10\text{ V}$, base open
*Collector-base breakdown voltage	BV_{CBO}	30			Volts	$I_C=100\text{ }\mu\text{A}$, $I_E=0$
*Collector-emitter breakdown voltage	BV_{CEO}	30			Volts	$I_C=100\text{ }\mu\text{A}$, $I_B=0$
*Emitter-collector breakdown voltage	BV_{ECO}	5.0			Volts	$I_E=100\text{ }\mu\text{A}$, $I_B=0$
DC current gain	h_{FE}		5000			$V_{CE}=5.0\text{ V}$, $I_C=500\text{ }\mu\text{A}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
(T _A =25°C unless otherwise noted)						
*Collector output current (Note 1) 4N32, 4N33	I_C	50			mA	$V_{CE}=10\text{ V}$, $I_F=10\text{ mA}$, $I_B=0$
*Collector-emitter saturation voltage (1) 4N32, 4N33	$V_{CE(SAT)}$			1.0	Volts	$I_C=2.0\text{ mA}$, $I_F=8.0\text{ mA}$

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
(Fig. 6 and 7)						
Turn-on time	t_{ON}		0.6	5.0	μs	$I_C=50\text{ mA}$, $I_F=200\text{ mA}$, $V_{CC}=10\text{ V}$
Turn-off time 4N32, 4N33	t_{OFF}		45	100	μs	$V_{CC}=10\text{ V}$
Bandwidth (3)			30		kHz	

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Isolation capacitance (Note 2)			0.8		pF	$V=0$, $f=1.0\text{ MHz}$
Isolation voltage (Note 2) 4N32, 4N33	V_{ISO}	5300	—	—	V	$I_{L0} \leq 1\text{ }\mu\text{A}$ V RMS, $t=1\text{ minute}$
*(4N32)		2500	—	—	V	VDC
*(4N33)		1500	—	—	V	VDC
Isolation resistance (Note 2)	R_{ISO}		10^{11}		Ohms	$V=500\text{ VDC}$

*Indicates JEDEC Registered Data.

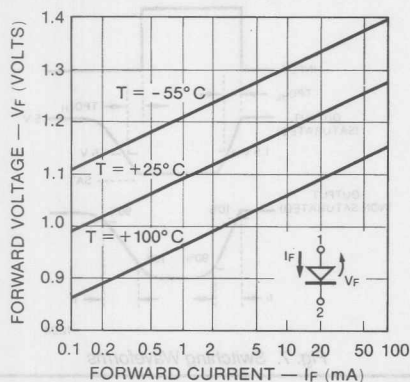
(1) Pulse test: pulse width=300 μs , duty cycle $\leq 2.0\%$

(2) For this test LED pins 1 and 2 are common and phototransistor pins 4, 5 and 6 are common.

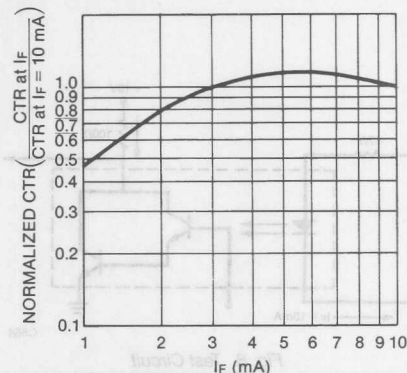
(3) I_F adjusted to $I_C=2.0\text{ mA}$ and $i_C=0.7\text{ mA RMS}$.(4) t_{on} and t_{off} are inversely proportional to the amplitude of I_F ; t_{on} and t_{off} are not significantly affected by I_F .

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

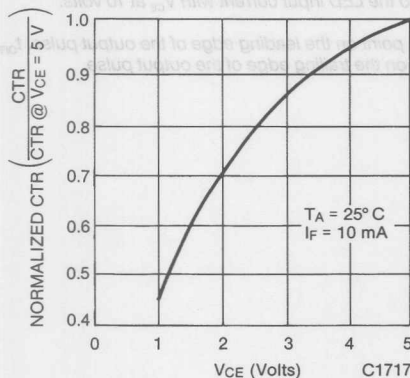
(25°C Free Air Temperature Unless Otherwise Specified)



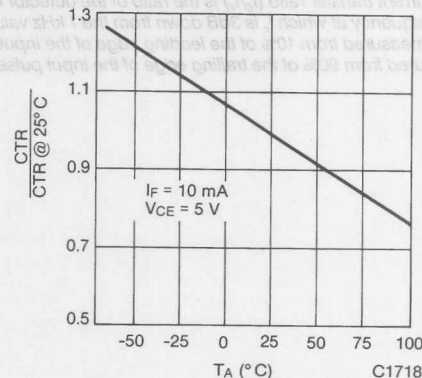
C1686



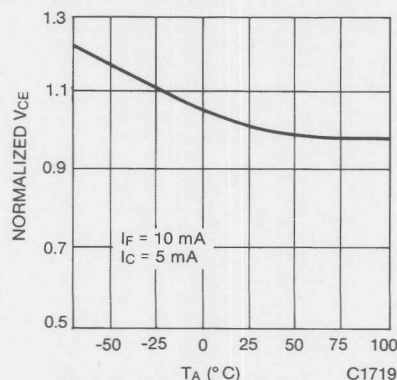
C1894



C1717



C1718



C1719

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

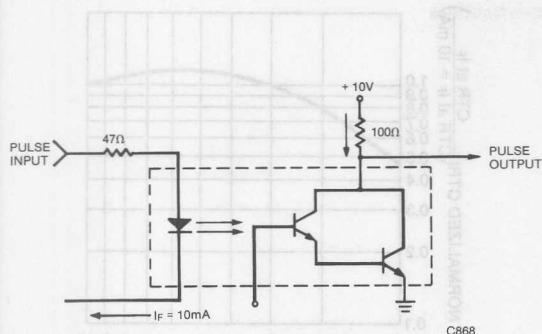


Fig. 6. Test Circuit

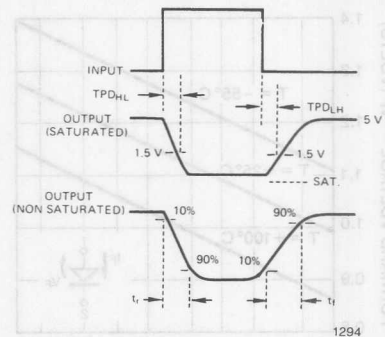


Fig. 7. Switching Waveforms

NOTES

1. The current transfer ratio (I_c/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
2. The frequency at which I_c is 3dB down from the 1 kHz value.
3. t_{ON} is measured from 10% of the leading edge of the input pulse to the 90% point on the leading edge of the output pulse. t_{OFF} is measured from 90% of the trailing edge of the input pulse to the 10% point on the trailing edge of the output pulse.

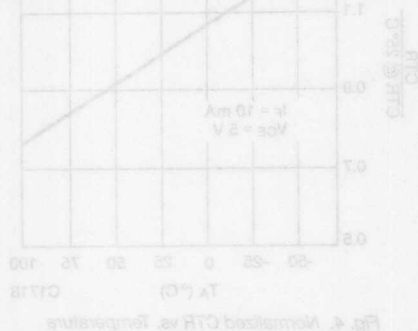


Fig. 4. Normalized CTR vs. Temperature

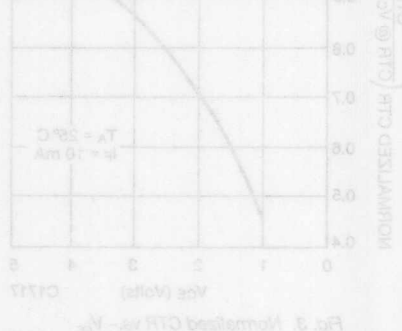


Fig. 5. Normalized CTR vs. V_{CE}

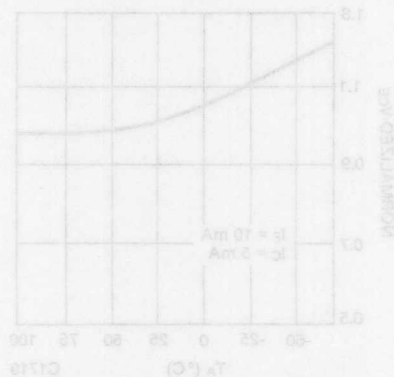
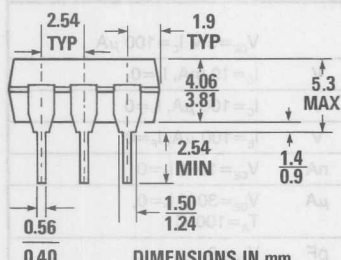
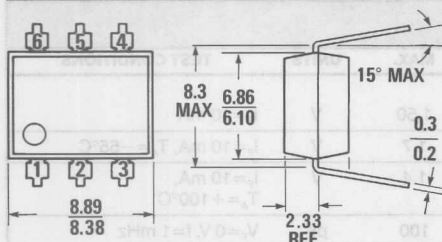


Fig. 6. Normalized V_{CE} vs. Temperature

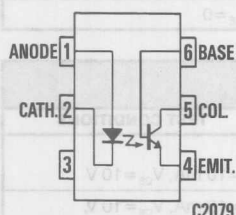
4N35 4N36 4N37

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



C2079

Equivalent Circuit

DESCRIPTION

The 4N35, 4N36, and 4N37 series of optocouplers have an NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- Industrial controls
- Covered under UL component recognition program, reference File E90700
- High DC current transfer ratio

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

- *Relative humidity 85% @ 85°C
- *Storage temperature -55°C to 150°C
- *Operating temperature -55°C to 100°C
- *Lead temperature (soldering, 10 sec) 260°C

INPUT DIODE

- *Forward DC current (continuous) 60 mA
- Reverse voltage 6 volts
- *Peak forward current
(1 μ s pulse, 300 pps) 3.0 A
- *Power dissipation at $T_A=25^\circ\text{C}$ 100 mW†
- *Power dissipation at $T_C=25^\circ\text{C}$ 100 mW†
(T_C indicates collector lead temp
1/32" from case)

OUTPUT TRANSISTOR

- *Power dissipation at 25°C ambient 300 mW
- Derate linearly above 25°C 4 mW/°C
- *Power dissipation at $T_C=25^\circ\text{C}$ 500 mW††
(T_C indicates collector lead temp
1/32" from case)

- * V_{CEO} 30 volts
- * V_{CBO} 70 volts
- * V_{ECO} 7 volts
- *Collector current (continuous) 100 mA

*Indicates JEDEC registered values

†Derate 1.33 mW/°C above 25°C.

††Derate 6.7 mW/°C above 25°C.

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
*Forward voltage	V_F	.8		1.50	V	$I_F = 10 \text{ mA}$
*Forward voltage temp. coefficient	V_F	.9		1.7	V	$I_F = 10 \text{ mA}$, $T_A = -55^\circ\text{C}$
*Forward voltage	V_F	.7		1.4	V	$I_F = 10 \text{ mA}$, $T_A = +100^\circ\text{C}$
*Junction capacitance	C_J			100	pF	$V_F = 0 \text{ V}$, $f = 1 \text{ MHz}$
*Reverse leakage current			.01	10	μA	$V_R = 6.0 \text{ V}$
DETECTOR						
DC forward current gain	h_{FE}		250			$V_{CE} = 5 \text{ V}$, $I_C = 100 \mu\text{A}$
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	$I_C = 10 \text{ mA}$, $I_F = 0$
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	$I_C = 100 \mu\text{A}$, $I_F = 0$
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	$I_E = 100 \mu\text{A}$, $I_F = 0$
Collector to emitter, leakage current	I_{CEO}		5	50	nA	$V_{CE} = 10 \text{ V}$, $I_F = 0$
*Collector to emitter leakage current (dark)	I_{CEO}			500	μA	$V_{CE} = 30 \text{ V}$, $I_F = 0$, $T_A = 100^\circ\text{C}$
Capacitance collector to emitter	C_{CEW}		8		pF	$V_{CE} = 0$
Capacitance collector to base	C_{CBO}		20		pF	$V_{CB} = 10 \text{ V}$
Capacitance base to emitter	C_{BEO}		10		pF	$V_{BE} = 0$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
COUPLED						
†*DC current transfer ratio	CTR	100			%	$I_F = 10 \text{ mA}$, $V_{CE} = 10 \text{ V}$
†*DC current transfer ratio	CTR	40			%	$I_F = 10 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $T_A = -55^\circ\text{C}$
†*DC current transfer ratio	CTR	40			%	$I_F = 10 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $T_A = +100^\circ\text{C}$
*Saturation voltage—collector to emitter	$V_{CE(SAT)}$			.3	volts	$I_F = 10 \text{ mA}$, $I_C = 0.5 \text{ mA}$

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
*Turn on time	t_{ON}		5	10	μsec	$V_{CC} = 10 \text{ V}$, $I_C = 2 \text{ mA}$, $R_L = 100\Omega$, (Fig. 10 and Fig. 11)
*Turn off time	t_{OFF}		5	10	μsec	$V_{CC} = 10 \text{ V}$, $I_C = 2 \text{ mA}$, $R_L = 100\Omega$, (Fig. 10 and Fig. 11)

*Indicates JEDEC registered values

†Pulse test: pulse width=300 μs ,
duty cycle $\leq 2.0\%$

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

ISOLATION CHARACTERISTICS

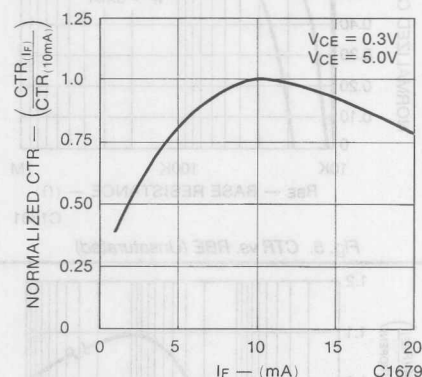
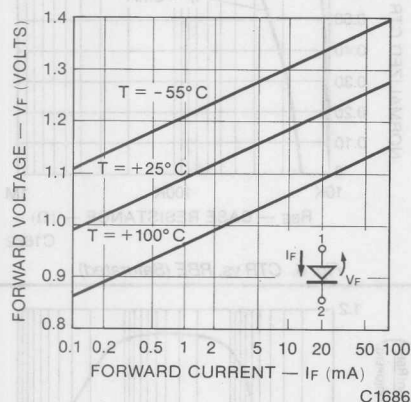
CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage all devices	V_{ISO}	5300			V_{RMS}	$I_{I/O} \leq 1 \mu A$ $t = 1 \text{ minute}$
*Input to output isolation current (pulse width=8 msec) (see Note 1)	$I_{I/O}$					
4N35				100	μA	$V_{ISO} = 3550 \text{ VAC (peak)}$
4N36				100	μA	$V_{ISO} = 2500 \text{ VAC (peak)}$
4N37				100	μA	$V_{ISO} = 1500 \text{ VAC (peak)}$
*Input to output resistance	$R_{I/O}$	100			gigaohms	Input to output voltage= 500 V (see Note 1)
*Input to output capacitance	$C_{I/O}$			2.5	picofarads	Input to output voltage= 0 V, $f = 1 \text{ MHz}$ (see Note 1)

*Indicates JEDEC registered values

†Pulse test: pulse width=300 μ S,
duty cycle $\leq$ 2.0%

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

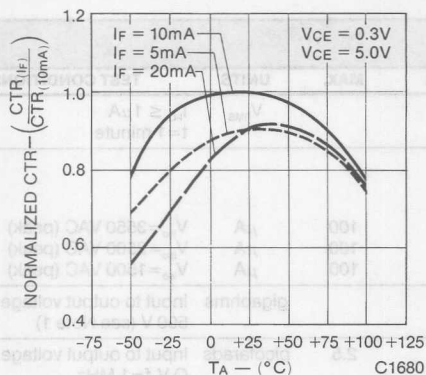


Fig. 3. Normalized CTR vs. Temperature

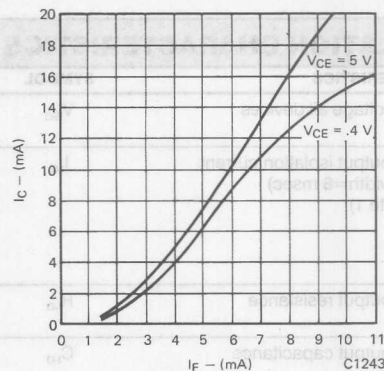


Fig. 4. Collector Current vs. Forward Current

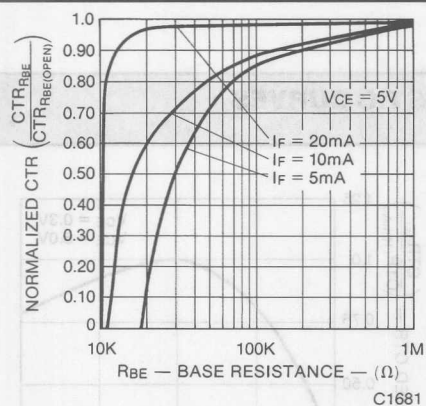


Fig. 5. CTR vs. R_{BE} (Unsaturated)

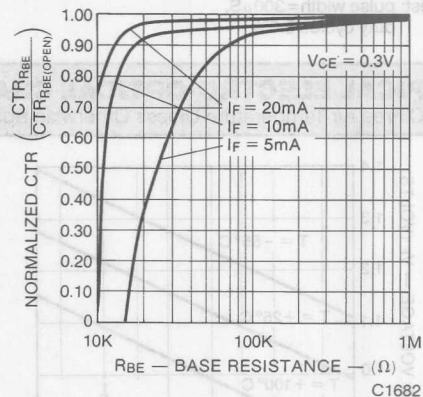


Fig. 6. CTR vs. R_{BE} (Saturated)

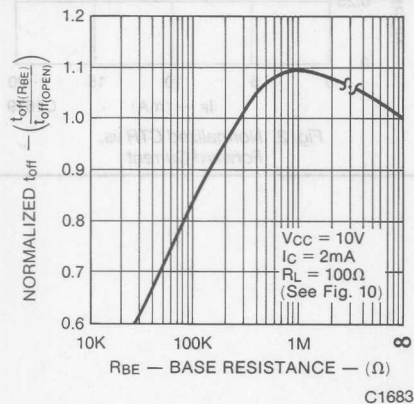


Fig. 7. Normalized T_{OFF} vs. R_{BE}

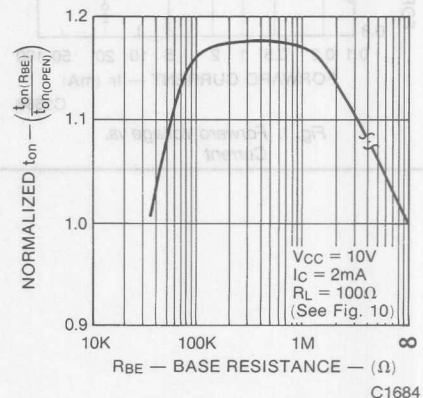
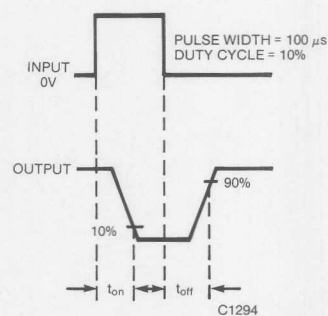
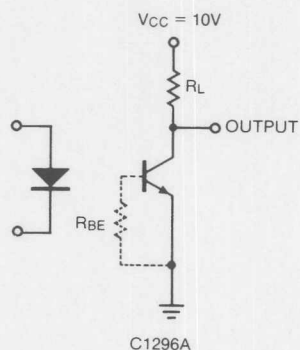
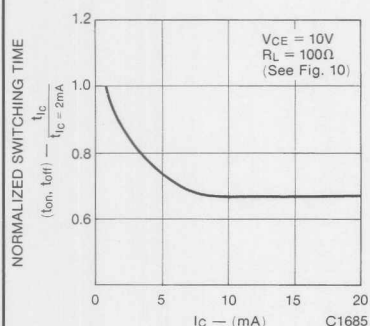


Fig. 8. Normalized T_{ON} vs. R_{BE}

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

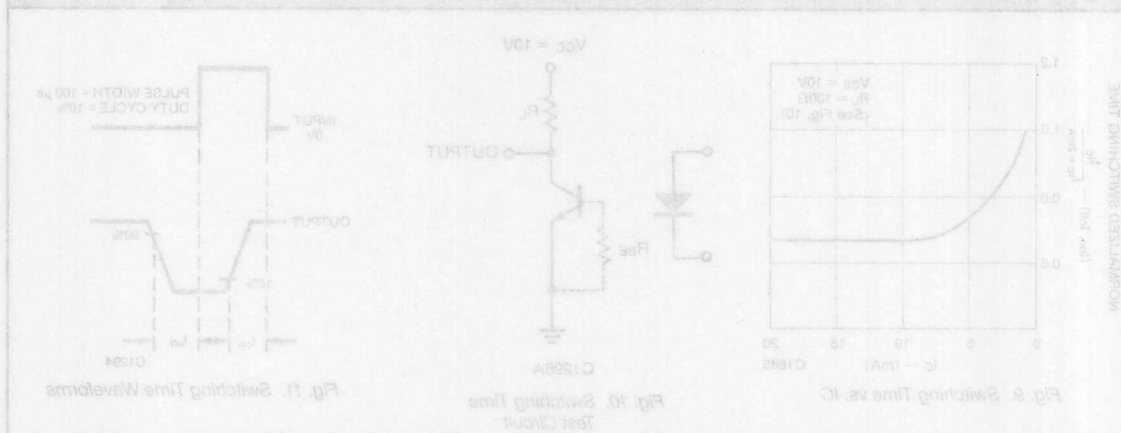


NOTES

1. Tests of input to output isolation current resistance and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.
2. The current transfer ratio (I_o/I_i) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.
Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

TYPICAL ALFETO-OPTICAL CHARACTERISTIC CURVES

Test Conditions: Ambient Temperature = 25°C, Collector Current = 10mA, Emitter Current = 10mA

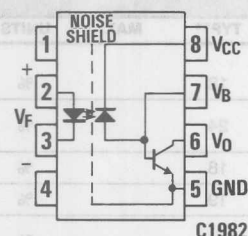
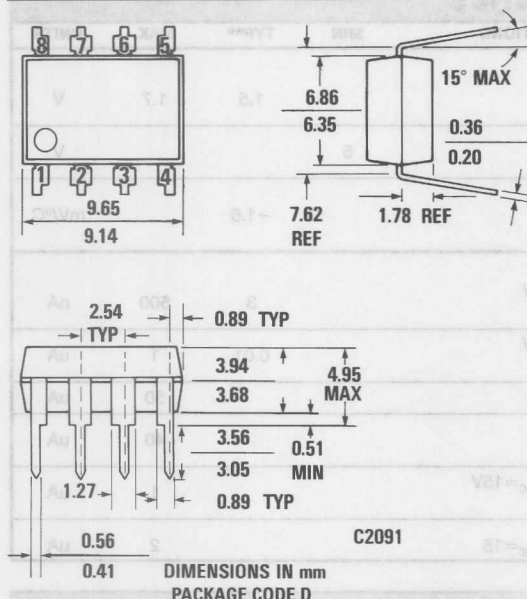


NOTES

1. Tests of input to output isolation current resistance and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.
2. The current transfer ratio (I_{CTR}) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%.
4. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

HCPL-2503 HCPL-4502 6N136 6N135

PACKAGE DIMENSIONS



The HCPL-4502 has the same specifications as the 6N136 but has no base connection.

DESCRIPTION

The HCPL-4502/HCPL-2503 and 6N136/5 optocouplers contain a 700 nm GaAsP LED emitter, which is optically coupled to a high speed photodetector transistor.

A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base-collector capacitance of the input transistor.

An internal noise shield provides superior common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard of 220 V.

FEATURES

- High Speed—1 MBit/s
- Superior CMR—10 kV/μs
- Double working voltage—480 V RMS
- CTR guaranteed 0-70°C
- U.L. recognized (File #E50151)

APPLICATIONS

- Line receivers
- Pulse transformer replacement
- Output interface to CMOS-LSTTL-TTL
- Wide bandwidth analog coupling

ABSOLUTE MAXIMUM RATINGS†

Storage temperature	−55°C to 125°C
Operating temperature	−55°C to 100°C
Lead solder temperature	260°C for 10s
Average forward input current	25 mA (1)
Peak forward input current	50 mA (2)
(50% duty cycle, 1ms P.W.)	
Peak transient input current - I _F	1.0 A
(≤1 μs P.W., 300 pps)	

Reverse input voltage	5 V
Input power dissipation	45 mW (3)
Average output current	8 mA
Peak output current	16 mA
Emitter-base reverse voltage	5 V
Supply and output voltage	−0.5 V to 15 V
Base current	5 mA
Output power dissipation	100 mW (4)

†Absolute Maximum Ratings are JEDEC Registered Data for 6N136 and 6N135.
6N136 and 6N135 are the only JEDEC Registered Parts on this data sheet.

ELECTRICAL CHARACTERISTICS ($T_A = 0-70^\circ$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	DEVICE	TEST CONDITIONS	MIN	TYP**	MAX.	UNITS
INPUT DIODE							
Input forward voltage	V_F		$I_F = 16\text{mA}$ $T_A = 25^\circ\text{C}$		1.5	1.7	V
Input reverse breakdown	B_{VR}		$I_R = 10\mu\text{A}$ $T_A = 25^\circ\text{C}$	5			V
Temperature coefficient of forward voltage	$\frac{\Delta V_F}{\Delta T_A}$		$I_F = 16\text{mA}$		-1.6		mV/ $^\circ\text{C}$
DETECTOR							
Logic high output current	I_{OH}		$I_F = 0\text{mA}$ $V_O = V_{CC} = 5.5\text{V}$ $T_A = 25^\circ\text{C}$		3	500	nA
			$I_F = 0\text{mA}$ $V_O = V_{CC} = 15\text{V}$ $T_A = 25^\circ\text{C}$		0.01	1	μA
			$I_F = 0\text{mA}$ $V_O = V_{CC} = 15\text{V}$			50	μA
Logic low supply	I_{CCL}		$I_F = 16\text{mA}$ $V_O = \text{OPEN}$ $V_{CC} = 15\text{V}$			40	μA
Logic high supply	I_{CCH}		$I_F = 0\text{mA}$ $V_O = \text{OPEN}$ $V_{CC} = 15\text{V}$ $T_A = 25^\circ\text{C}$			1	μA
			$I_F = 0\text{mA}$ $V_O = \text{OPEN}$ $V_{CC} = 15\text{V}$			2	μA

TRANSFER CHARACTERISTICS

PARAMETER	SYMBOL	DEVICE	TEST CONDITIONS	MIN	TYP**	MAX.	UNITS
COUPLED							
Current transfer Ratio (Note 5)	CTR	6N135		7	18		%
		6N136	$I_F = 16\text{mA}$ $V_O = 0.4\text{V}$	19	24		%
		HCPL-4502	$V_{CC} = 4.5\text{V}$ $T_A = 25^\circ\text{C}$	12	18		%
		HCPL-2503		5	19		%
		6N136	$I_F = 16\text{mA}$ $V_O = 0.5\text{V}$	15	25		%
		HCPL-4502	$V_{CC} = 4.5\text{V}$	9			%
Logic low output voltage	V_{OL}	6N135	$I_F = 16\text{mA}$ $I_O = 1.1\text{mA}$ $V_{CC} = 4.5\text{V}$ $T_A = 25^\circ\text{C}$		0.1	0.4	V
		6N136	$I_F = 16\text{mA}$ $I_O = 2.4\text{mA}$		0.1	0.4	V
		HCPL-4502	$V_{CC} = 4.5\text{V}$ $T_A = 25^\circ\text{C}$				

SWITCHING CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified $V_{CC} = 5\text{V}$)

PARAMETER	SYMBOL	DEVICE	TEST CONDITIONS	MIN	TYP**	MAX.	UNITS
Propagation delay time to logic low	t_{PHL}	6N135	$R_L = 4.1\text{K}$ $I_F = 16\text{mA}$ Note 8 Fig. 7		0.2	1.5	μS
		6N136					
		HCPL-4502	$R_L = 1.9\text{K}$ $I_F = 16\text{mA}$ Note 9 Fig. 7		0.2	0.8	μS
		HCPL-2503					
Propagation delay time to logic high	t_{PHL}	6N135	$R_L = 4.1\text{K}$ $I_F = 16\text{mA}$ Note 8 Fig. 7		1.3	1.5	μS
		6N136					
		HCPL-4502	$R_L = 1.9\text{K}$ $I_F = 16\text{mA}$ Note 9 Fig. 7		0.6	0.8	μS
		HCPL-2503	Note 7 Fig. 6				
Common mode transient immunity at logic high	CM_H	6N135	$I_F = 0\text{mA}$, $V_{CM} = 10V_{P,P}$, $R_L = 4.1\text{K}$		10,000		$\text{V}/\mu\text{S}$
		6N136	$I_F = 0\text{mA}$, $V_{CM} = 10V_{P,P}$				
		HCPL-4502	$R_L = 1.9\text{K}$		10,000		$\text{V}/\mu\text{S}$
		HCPL-2503	Note 7 Fig. 6				
Common mode transient immunity at logic low	CM_L	6N135	$I_F = 16\text{mA}$, $V_{CM} = 10V_{P,P}$, $R_L = 4.1\text{K}$		10,000		$\text{V}/\mu\text{S}$
		6N136	$I_F = 16\text{mA}$, $V_{CM} = 10V_{P,P}$				
		HCPL-4502	$R_L = 1.9\text{K}$		10,000		$\text{V}/\mu\text{S}$
		HCPL-2503	Note 7 Fig. 6				
Bandwidth	BW		See test circuit Note 10		2		MHz

ISOLATION CHARACTERISTICS

PARAMETER	SYMBOL	DEVICE	TEST CONDITIONS	MIN	TYP**	MAX.	UNITS
Input-output insulation leakage	I_{IO}		45% relative humidity $t = 5\text{sec}$ $V_{IO} = 3000\text{VDC}$ $T_A = 25^\circ\text{C}$, note 6			1.0	μA
Withstand insulation voltage	V_{ISO}		$RH \leq 50\%$ $t = 1\text{min}$ $T_A = 25^\circ\text{C}$ Note 11	2500			V RMS
Resistance input-output	R_{IO}		$V_{IO} = 500\text{VDC}$		10^{12}		Ω
Capacitance	C_{IO}		$F = 1\text{MHz}$		0.6		pF
DC current gain	HFE		$I_O = 3\text{mA}$ $V_O = 5\text{V}$		150		

NOTES

- Derate linearly above 70°C free-air temperature at a rate of $0.8\text{ mA}/^\circ\text{C}$.
- Derate linearly above 70°C free-air temperature at a rate of $1.6\text{ mA}/^\circ\text{C}$.
- Derate linearly above 70°C free-air temperature at a rate of $0.9\text{ mW}/^\circ\text{C}$.
- Derate linearly above 70°C free-air temperature at a rate of $1.0\text{ mW}/^\circ\text{C}$.
- CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_O , to the forward LED input current, I_F , times 100%.
- Device considered a two-terminal: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
- Common mode transient immunity in Logic High level is the maximum tolerable (positive) dV_{CM}/dt on the leading edge of the common mode pulse V_{CM} , to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0\text{V}$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) dV_{CM}/dt on the trailing edge of the common mode pulse signal, V_{CM} , to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8\text{V}$).
- The $4.1\text{K}\Omega$ load represents 1 LSTTL unit load of 0.36 mA and $6.1\text{K}\Omega$.
- The $1.9\text{K}\Omega$ load represents 1 TTL unit load of 1.6 mA and the $5.6\text{K}\Omega$ pull-up resistor.
- The frequency at which the ac output voltage is 3 dB below the low frequency asymptote.
- The $2500\text{ Vac}/1\text{ min}$ capability is validated by a factory $3.1\text{K Vac (rms)}/1\text{ sec}$ dielectric voltage withstand test.

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

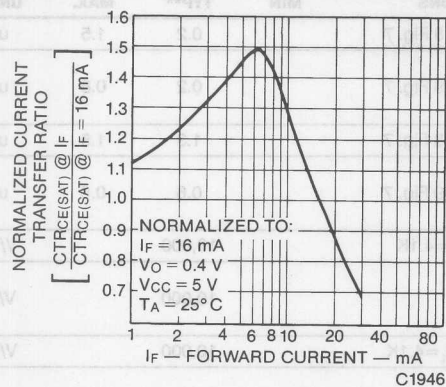


Fig. 1. Normalized Current Transfer Ratio vs. Forward Current

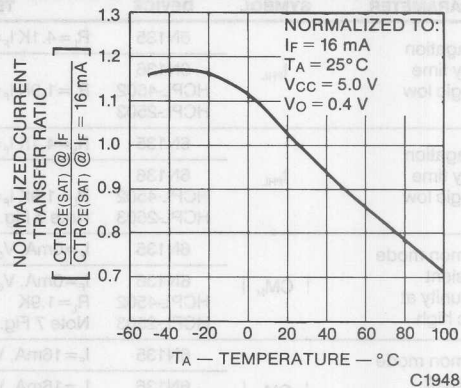


Fig. 2. Normalized Current Transfer Ratio vs. Temperature

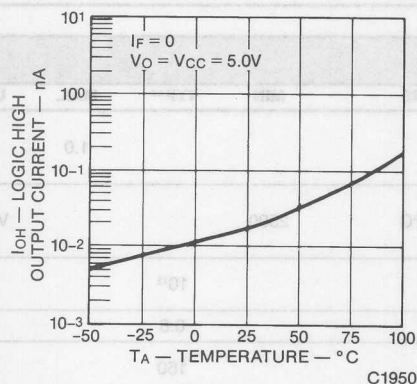


Fig. 3. Logic High Output Current vs. Temperature

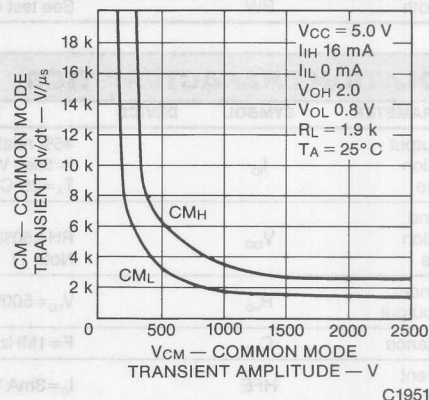


Fig. 4. Common Mode Transient Immunity vs. Common Mode Transient Amplitude

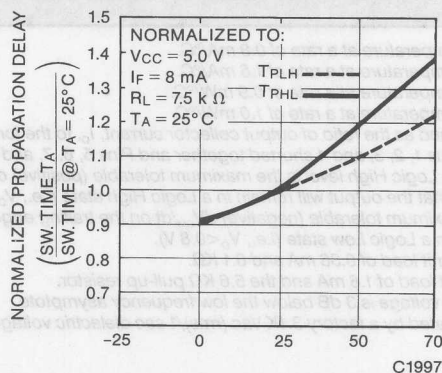
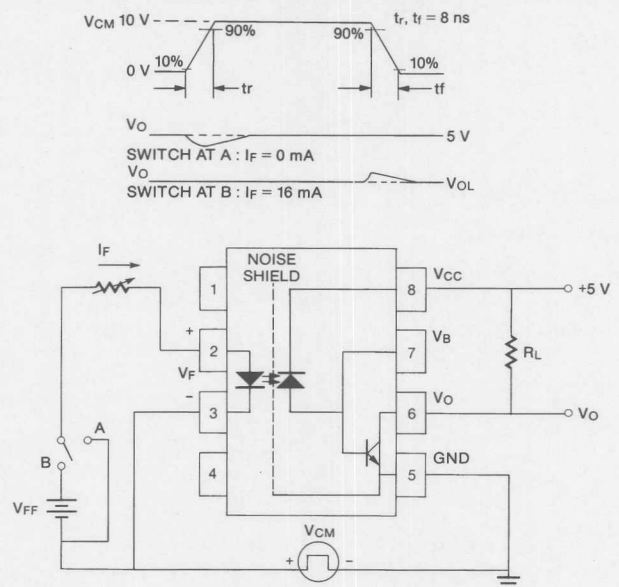


Fig. 5. Normalized Propagation Delay vs. Temperature at $I_F = 8\text{ mA}$

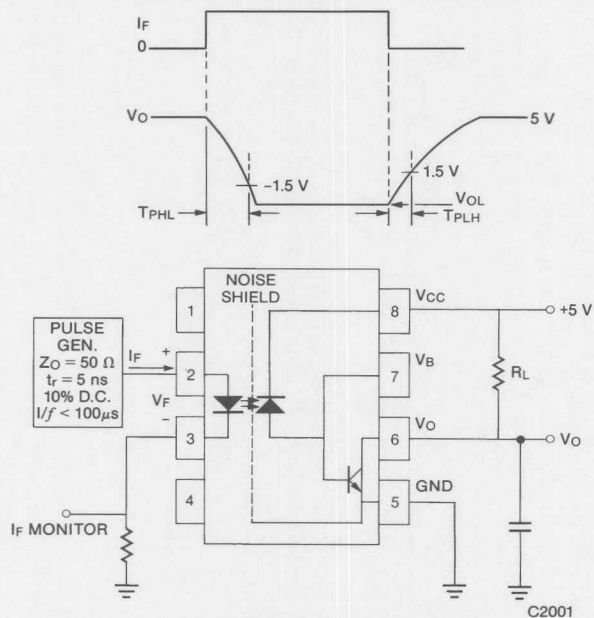
ELECTRICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)



C2000

Fig. 6. Common Mode Immunity Test Circuit



C2001

Fig. 7. Switching Time Test Circuit

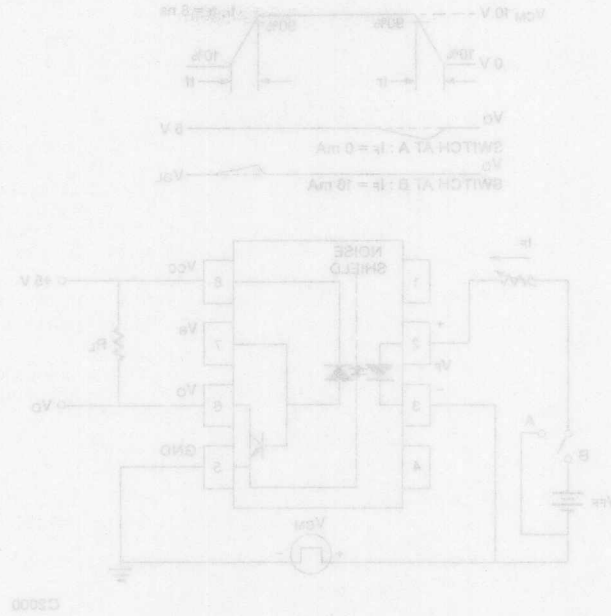


Fig. 6. Common Mode Immunity Test Circuit

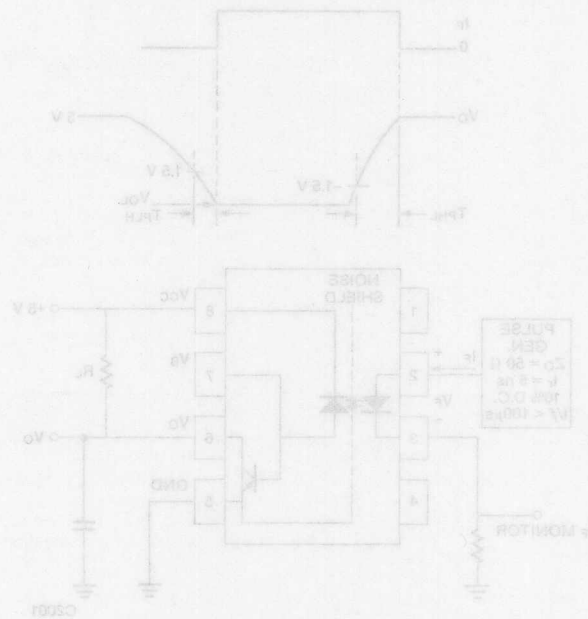
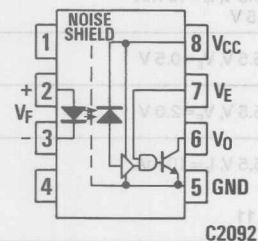
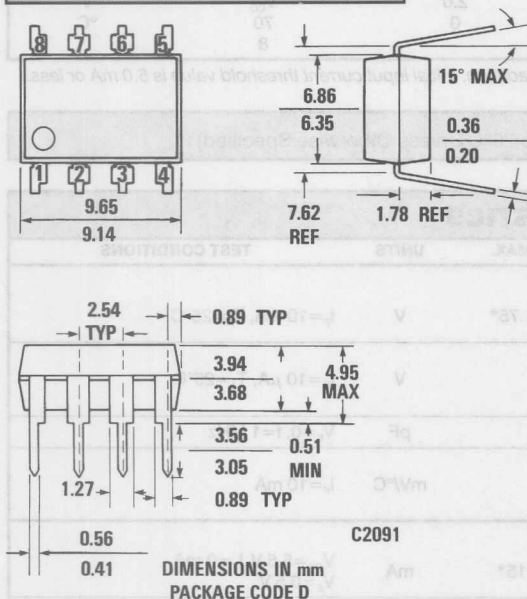


Fig. 7. Switching Time Test Circuit

**6N137
HCPL-2611
10 MBit/s LOGIC GATE HCPL-2601**

PACKAGE DIMENSIONS



Equivalent Circuit

**TRUTH TABLE
(Positive Logic)**

Input	Enable	Output
H	H	L
L	H	H
H	L	H
L	L	H

A 0.1μF bypass capacitor must be connected between pins 8 and 5.
(See note 1)

DESCRIPTION

The 6N137 and HCPL-2601 single-channel optocouplers consists of a 700 nm GaAsP LED, optically coupled to a very high speed integrated photodetector logic gate with a strobable output. This output features an open collector, thereby permitting wired-OR outputs. The coupled parameters are guaranteed over the temperature range of 0-70°C. A maximum input signal of 5 mA will provide a minimum output sink current of 13 mA (fan-out of 8).

An internal noise shield provides superior common mode rejection of typically 10 kV/μs. The HCPL-2601 has a minimum CMR of 1 kV/μs. The HCPL-2611 has a minimum CMR of 3.5kV/μsec.

An improved package allows superior insulation, permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Very high speed—10 MBit/s
- Superior CMR—10 kV/μs
- Double working voltage—480 V
- Fan-out of 8 over 0-70°C
- Logic gate output
- Storable output
- Wired-OR—open collector
- U.L. recognized (File #E50151)

APPLICATIONS

- Ground loop elimination
- LSTTL to TTL, LSTTL or 5-volt CMOS
- Line receiver, data transmission
- Data multiplexing
- Switching power supplies
- Pulse transformer replacement
- Computer-peripheral interface

ABSOLUTE MAXIMUM RATINGS

Storage temperature -55°C to +125°C
Operating temperature 0°C to +70°C
Lead solder temperature 260°C for 10 s

INPUT DIODE

DC/average forward input current 20 mA
Enable input voltage, (V_E)
(not to exceed V_{CC} by more than 500 mV) 5.5 V
Reverse input voltage 5.0 V
Reverse supply voltage (-V_{CC}) -500 mV

OUTPUT TRANSISTOR

Supply voltage, (V_{CC}) 7.0 V/1 minute maximum
Output current, (I_O) 25 mA
Output voltage, (V_O) 7.0 V
Collector output power dissipation 40 mW

RECOMMENDED OPERATING CONDITIONS

	SYMBOL	MIN.	MAX	UNITS
Input current, low level	I_{FL}	0	250	μA
Input current, high level	I_{FH}	*6.3	15	mA
Supply voltage, output	V_{CC}	4.5	5.5	V
Enable voltage low level	V_{EL}	0	0.8	V
Enable voltage high level	V_{EH}	2.0	V_{CC}	V
Operating temperature	T_A	0	70	$^{\circ}C$
Fan out (TTL load)	N		8	

*6.3 mA is a guard banded value which allows for at least 20% CTR degradation. Initial input current threshold value is 5.0 mA or less.

ELECTRICAL CHARACTERISTICS ($T_A=0^{\circ}C$ to $70^{\circ}C$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYM.	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Input forward voltage	V_F		1.55	1.75*	V	$I_F=10$ mA, $T_A=25^{\circ}C$
Input reverse breakdown voltage	B_{VR}	5.0*			V	$I_R=10$ μA , $T_A=25^{\circ}C$
Input capacitance	C_{IN}		60		pF	$V_F=0$, $f=1$ MHz
Input diode temperature coefficient	$\Delta V_F/\Delta T_A$		-1.4		mV/ $^{\circ}C$	$I_F=10$ mA
DETECTOR						
High level supply current	I_{OCH}		10	15*	mA	$V_{CC}=5.5$ V, $I_F=0$ mA $V_E=0.5$ V
Low level supply current	I_{OCL}		15	18*	mA	$V_{CC}=5.5$ V, $I_F=10$ mA $V_E=0.5$ V
Low level enable current	I_{EL}		-1.5	-2.0*	mA	$V_{CC}=5.5$ V, $V_E=0.5$ V
High level enable current	I_{EH}		-1.0		mA	$V_{CC}=5.5$ V, $V_E=2.0$ V
High level enable voltage	V_{EH}	2.0			V	$V_{CC}=5.5$ V, $I_F=10$ mA
Low level enable voltage	V_{EL}			0.8	V	Note: 11

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYM.	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
High level output current	I_{OH}		.02	250*	μA	$V_{CC}=5.5$ V, $V_O=5.5$ V $I_F=250$ μA , $V_E=2.0$ V
Low level output voltage	V_{OL}		.34	0.6*	V	$V_{CC}=5.5$ V, $I_F=5$ mA $V_E=2.0$ V, $I_{OL}=13$ mA

ELECTRICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYM.	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
Propagation delay time (for output high level)	T_{PLH}		48	75*	ns	$R_L=350\Omega$ $C_L=15\text{pF}$ Fig. 7
Propagation delay time (for output low level)	T_{PHL}		48	75*	ns	$R_L=350\Omega$ Fig. 7 $C_L=15\text{pF}$
Output rise time (10-90%)	t_r		30		ns	$I_F=7.5\text{mA}$ Fig. 7
Output fall time (90-10%)	t_f		14		ns	Notes 2, 3, 4 & 5, Fig. 7
Enable propagation delay time (for output high level)	t_{ELH}		25		ns	$I_F=7.5\text{mA}$ $V_{EH}=3.0\text{V}$ Fig. 8
Enable propagation delay time (for output low level)	t_{EHL}		14		ns	$R_L=350\Omega$, $C_L=15\text{pf}$ Notes 6 & 7, Fig. 8
Common mode transient immunity (at output high level)	CM_H		10,000		$\text{V}/\mu\text{s}$	$V_{CM}=50\text{V}$ (Peak) $I_F=0\text{mA}$, $V_{OH}(\text{Min.})=2.0\text{V}$ $R_L=350\Omega$, Note 9 Fig. 13
		1000	10,000			6N137 HCPL-2601
		3500	12,000			$V_{CM}=400\text{V}$ HCPL-2611
Common mode transient immunity (at output low level)	CM_L		10,000		$\text{V}/\mu\text{s}$	$V_{CM}=50\text{V}$ (Peak) $I_F=7.5\text{mA}$, $V_{OL}(\text{Max.})=0.8\text{V}$ $R_L=350\Omega$ Note 8, Fig. 13
		1000	10,000			6N137 HCPL-2601
		3500	11,000			$V_{CM}=400\text{V}$ HCPL-2611

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYM.	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
Input-output insulation leakage current	I_{LO}			1.0*	μA	Relative humidity=45% $T_A=25^\circ\text{C}$, $t=5\text{s}$ $V_{LO}=3000\text{VDC}$ Note: 10
Withstand insulation test voltage	V_{ISO}	2500			V_{RMS}	$\text{RH}<50\%$ $T_A=25^\circ\text{C}$ $t=1\text{min.}$
Resistance (input to output)	R_{LO}		10^{12}		Ω	$V_{LO}=500\text{V}$, Note: 10
Capacitance (input to output)	C_{LO}		0.6		pF	$f=1\text{MHz}$, Note: 10

*JEDEC Registered Data

**All typical values are at $V_{CC}=5\text{V}$, $T_A=25^\circ\text{C}$

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

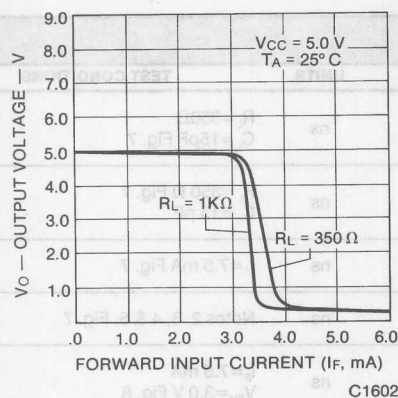


Fig. 1. Output Voltage vs. Forward Input Current

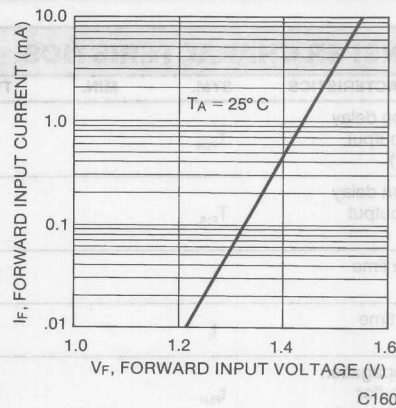


Fig. 2. Forward Input Current vs. Forward Input Voltage

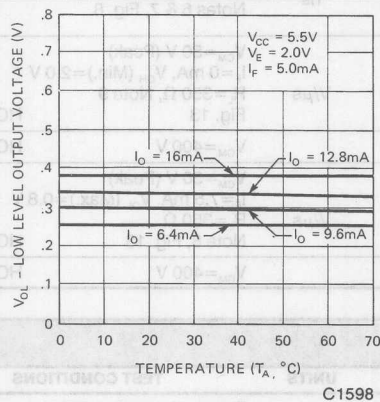


Fig. 3. Low Level Output Voltage vs. Temperature

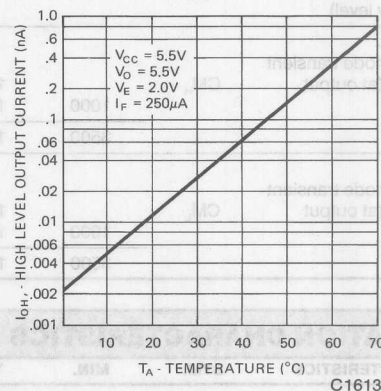


Fig. 4. High Level Output Current vs. Temperature

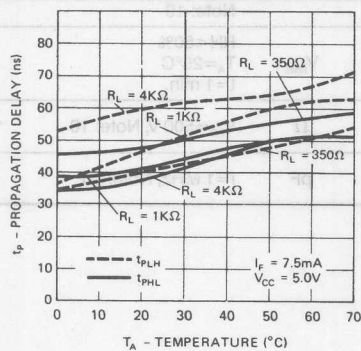


Fig. 5. Propagation Delay vs. Temperature

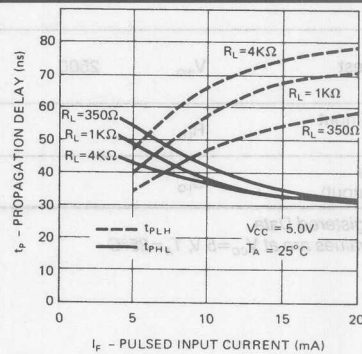


Fig. 6. Propagation Delay vs. Pulse Input Current

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

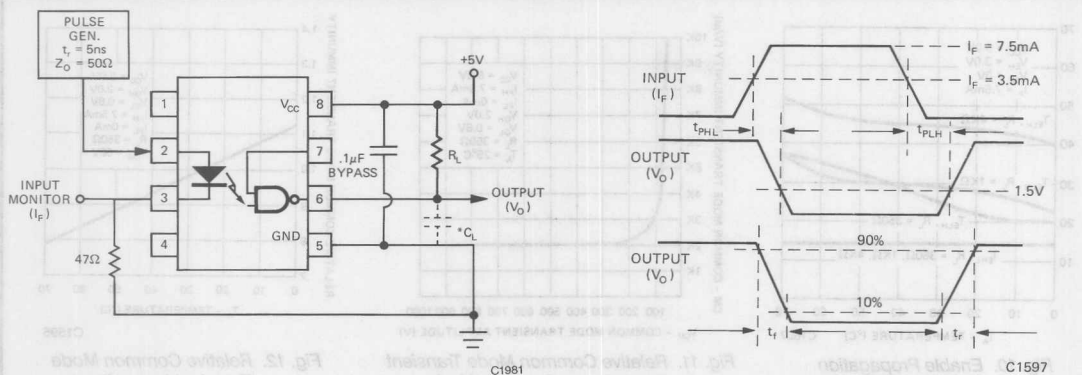


Fig. 7. Test Circuit and Waveforms for t_{PLH} , t_r , and t_f

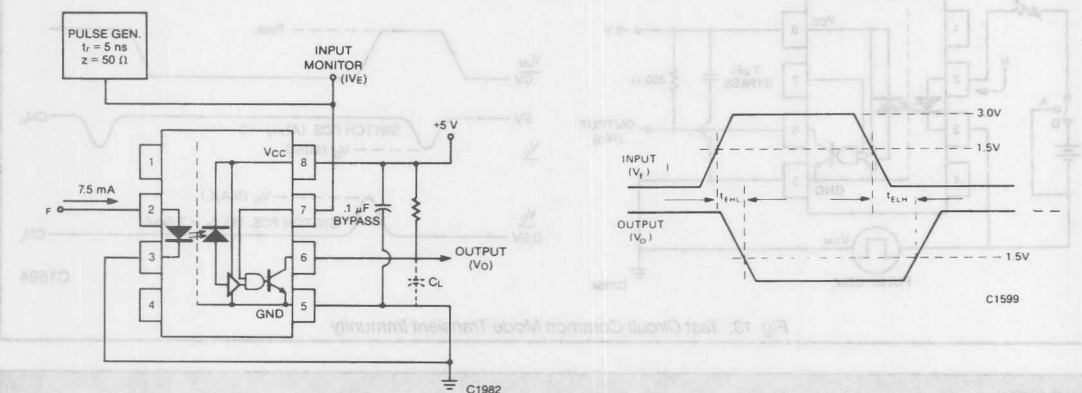


Fig. 8. Test Circuit t_{EHL} and t_{ELH}

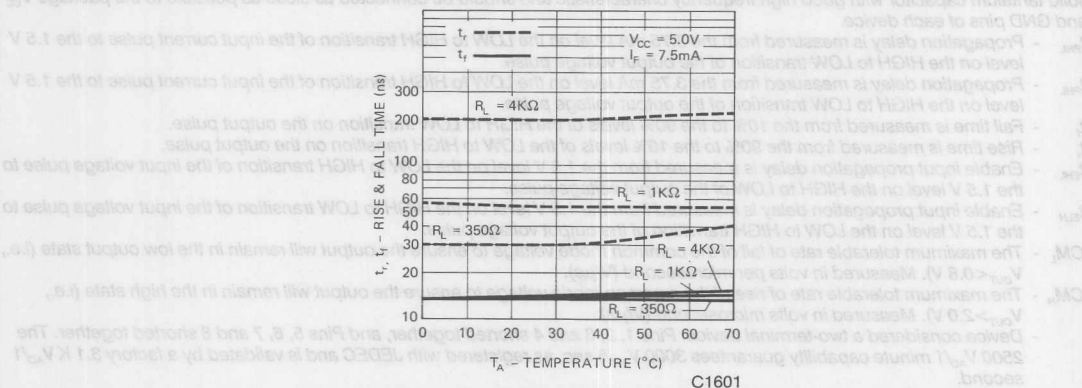


Fig. 9. Rise and Fall Time vs. Temperature

TYPICAL CHARACTERISTIC CURVES ($T_A=25^{\circ}\text{C}$ Unless Otherwise Specified) (Cont'd)

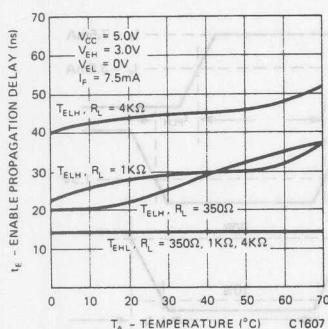


Fig. 10. Enable Propagation Delay vs. Temperature

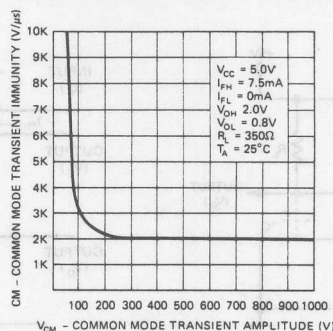


Fig. 11. Relative Common Mode Transient Immunity vs. Common Mode Transient Amplitude

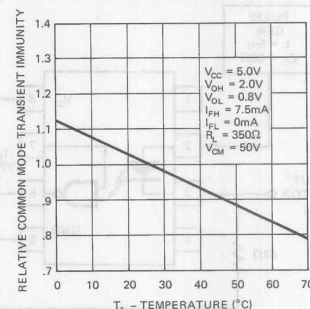


Fig. 12. Relative Common Mode Transient Immunity vs. Temperature

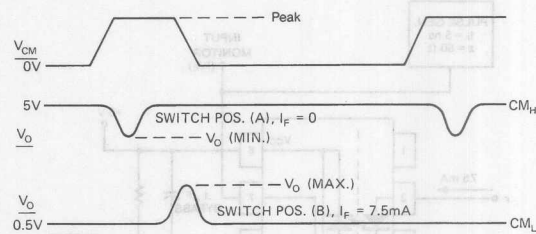
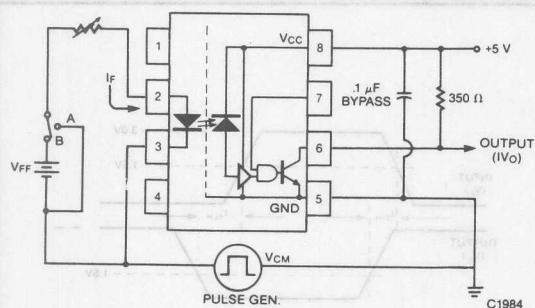


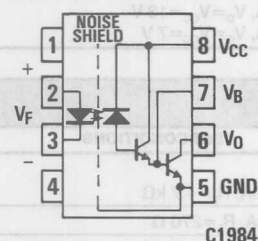
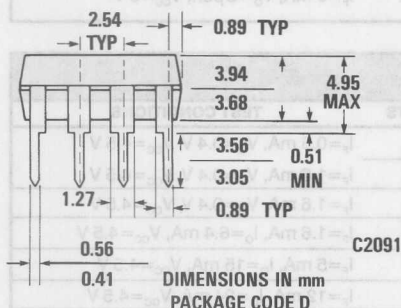
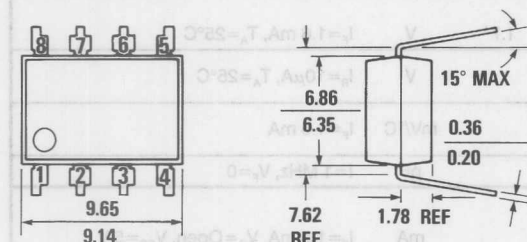
Fig. 13. Test Circuit Common Mode Transient Immunity

NOTES

1. The V_{CC} supply voltage to each 6N137 isolator must be bypassed by the V_{CC} by a $0.1\ \mu\text{F}$ capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristic and should be connected as close as possible to the package V_{CC} and GND pins of each device.
2. t_{PHL} - Propagation delay is measured from the 3.75 mA level on the LOW to HIGH transition of the input current pulse to the 1.5 V level on the HIGH to LOW transition of the output voltage pulse.
3. t_{PLH} - Propagation delay is measured from the 3.75 mA level on the LOW to HIGH transition of the input current pulse to the 1.5 V level on the HIGH to LOW transition of the output voltage pulse.
4. t_f - Fall time is measured from the 10% to the 90% levels of the HIGH to LOW transition on the output pulse.
5. t_r - Rise time is measured from the 90% to the 10% levels of the LOW to HIGH transition on the output pulse.
6. t_{EHL} - Enable input propagation delay is measured from the 1.5 V level on the LOW to HIGH transition of the input voltage pulse to the 1.5 V level on the HIGH to LOW of the output voltage pulse.
7. t_{ELH} - Enable input propagation delay is measured from the 1.5 V level on the HIGH to LOW transition of the input voltage pulse to the 1.5 V level on the LOW to HIGH transition of the output voltage pulse.
8. CM_L - The maximum tolerable rate of fall of the common mode voltage to ensure the output will remain in the low output state (i.e., $V_{OUT} < 0.8\text{ V}$). Measured in volts per microsecond ($\text{V}/\mu\text{s}$).
9. CM_H - The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e., $V_{OUT} > 2.0\text{ V}$). Measured in volts microsecond ($\text{V}/\mu\text{s}$).
10. - Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together. The $2500\text{ V}_{AC}/1\text{ minute}$ capability guarantees $3000\text{ V}_{DC}/5\text{ sec.}$ as registered with JEDEC and is validated by a factory $3.1\text{ K V}_{AC}/1\text{ second}$.
11. Enable Input - No pull up resistor required as the device has an internal pull up resistor.
12. - DC current transfer ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.

**6N138
6N139**

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The 6N138/9 single channel optocouplers contain a 700 nm GaAsP LED emitter which is optically coupled to a high gain detector in a split Darlington configuration, providing extremely high current transfer ratio.

The split darlington configuration separating the input photodiode and the first stage gain from the output transistor permits lower output saturation voltage and higher speed operation than possible with conventional darlington phototransistor optocoupler.

The combination of a very low input current of 0.5 mA and a high current transfer ratio of 2000% makes this family particularly useful for input interface to MOS, CMOS, LSTTL and EIA RS232C, while output compatibility is ensured to CMOS as well as high fan-out TTL requirements.

An internal noise shield provides exceptional common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Low current—0.5 mA
- Superior CTR—2000%
- Superior CMR—10 kV/μs
- Double working voltage—480 V RMS
- CTR guaranteed 0-70°C
- U.L. recognized (File #E50151)

APPLICATIONS

- Digital logic ground isolation
- Telephone ring detector
- EIA RS-232C line receiver
- High common mode noise line receiver
- μP bus isolation
- Current loop receiver

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55°C to +125°C
Operating temperature	0°C to +70°C
Lead solder temperature	260°C for 10 sec

INPUT DIODE

Average input current	20 mA (1)
Peak input current (50% duty cycle, 1 ms P.W.)	40 mA
Peak transient input current— I_F (≤1 μsec P.W., 300 pps)	1.0 A
Reverse input voltage	5V
Input power dissipation	35 mW (2)

OUTPUT TRANSISTOR

Output current (Pin 6)	60 mA (3)
Emitter-base reverse voltage (Pin 5-7)	5 V
Supply and output voltage— V_{CC} (Pin 8-5), V_O (Pin 6-5)	6N138 -0.5 to 7 V
	6N139 -0.5 to 18 V
Output power dissipation	100 mW (4)

ELECTRICAL SPECIFICATIONS ($T_A=0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	DEVICE	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE							
Input forward voltage	V_F			1.45	1.7*	V	$I_F=1.6\text{ mA}$, $T_A=25^{\circ}\text{C}$
Reverse breakdown voltage	BV_R		5*			V	$I_R=10\mu\text{A}$, $T_A=25^{\circ}\text{C}$
Temperature coefficient of forward voltage	$\frac{\Delta V_F}{\Delta T_A}$			-1.8		mV/ $^{\circ}\text{C}$	$I_F=1.6\text{ mA}$
Input capacitance	C_O			60		pF	$f=1\text{ MHz}$, $V_F=0$
DETECTION							
Logic low supply current (Note 6)	I_{CCL}			0.20		mA	$I_F=1.6\text{ mA}$, $V_O=\text{Open}$, $V_{CC}=5\text{ V}$
Logic high supply current (Note 6)	I_{CCH}			10.0		nA	$I_F=0\text{ mA}$, $V_O=\text{Open}$, $V_{CC}=5\text{ V}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	DEVICE	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
Current transfer ratio (Notes 5, 6)	CTR	6N139	400*	2000		%	$I_F=0.5\text{ mA}$, $V_O=0.4\text{ V}$, $V_{CC}=4.5\text{ V}$
		6N139	500*	2000		%	$I_F=1.6\text{ mA}$, $V_O=0.4\text{ V}$, $V_{CC}=4.5\text{ V}$
		6N138	300*	2000		%	$I_F=1.6\text{ mA}$, $V_O=0.4\text{ V}$, $V_{CC}=4.5\text{ V}$
Logic low output voltage (Note 6)	V_{OL}	6N139		0.06	0.4	V	$I_F=1.6\text{ mA}$, $I_O=6.4\text{ mA}$, $V_{CC}=4.5\text{ V}$
		6N139		0.08	0.4	V	$I_F=5\text{ mA}$, $I_O=15\text{ mA}$, $V_{CC}=4.5\text{ V}$
		6N139		0.09	0.4	V	$I_F=12\text{ mA}$, $I_O=24\text{ mA}$, $V_{CC}=4.5\text{ V}$
Logic high output current (Note 6)	I_{OH}	6N138		0.06	0.4	V	$I_F=1.6\text{ mA}$, $I_O=4.8\text{ mA}$, $V_{CC}=4.5\text{ V}$
		6N139		0.1	100*	μA	$I_F=0\text{ mA}$, $V_O=V_{CC}=18\text{ V}$
		6N138		0.001	250*	μA	$I_F=0\text{ mA}$, $V_O=V_{CC}=7\text{ V}$

SWITCHING SPECIFICATIONS ($T_A=25^{\circ}\text{C}$, $V_{CC}=5.0\text{ V}$)

PARAMETER	SYMBOL	DEVICE	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
TRANSISTOR AC							
Propagation delay time to logic low at output (see Fig. 5; Notes 6, 8)	t_{PHL}	6N139		5.0	25*	μs	$I_F=0.5\text{ mA}$, $R_L=4.7\text{ k}\Omega$
		6N139		0.2	1*	μs	$I_F=12\text{ mA}$, $R_L=270\text{ }\Omega$
		6N138		1.0	10*	μs	$I_F=1.6\text{ mA}$, $R_L=2.2\text{ k}\Omega$
Propagation delay time to logic high at output (see Fig. 5; Notes 6, 8)	t_{PLH}	6N139		1.0	60*	μs	$I_F=0.5\text{ mA}$, $R_L=4.7\text{ k}\Omega$
		6N139		1.0	7*	μs	$I_F=12\text{ mA}$, $R_L=270\text{ }\Omega$
		6N138		4.0	35*	μs	$I_F=1.6\text{ mA}$, $R_L=2.2\text{ k}\Omega$
Common mode transient immunity at logic high level output (see Fig. 6; Note 9)	CM_H		1000	10,000		V/ μs	$I_F=0\text{ mA}$, $R_L=2.2\text{ k}\Omega$ $ V_{cm} =10\text{ V}_{pp}$
Common mode transient immunity at logic low level output (see Fig. 6; Note 9)	CM_L		-1000	-10,000		V/ μs	$I_F=1.6\text{ mA}$, $R_L=2.2\text{ k}\Omega$ $ V_{cm} =10\text{ V}_{pp}$

*JEDEC registered data

**All typicals at $T_A=25^{\circ}\text{C}$ and $V_{CC}=5\text{ V}$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	DEVICE	MIN.	TYP.**	MAX.	UNITS	TEST CONDITIONS
Isolation leakage (Input-Output) (Note 7)	I_{i-o}				1.0*	μA	45% Relative Humidity, $T_A = 25^\circ C$ $V_{i-o} = 3000 V$, $t_d = 5 \text{ sec}$
Withstand isolation test voltage	V_{iso}		2500			V_{RMS}	$RH \leq 50\%$, $T_A = 25^\circ C$, $t = 1 \text{ min}$
Resistance (Input-Output) (Note 7)	R_{i-o}			10^{12}		Ω	$V_{i-o} = 500 Vdc$
Capacitance (Input-Output) (Note 7)	C_{i-o}			0.6		pF	$f = 1 \text{ MHz}$

NOTES

- Derate linearly above $50^\circ C$ free-air temperature at a rate of $0.4 \text{ mA}/^\circ C$.
- Derate linearly above $50^\circ C$ free-air temperature at a rate of $0.7 \text{ mW}/^\circ C$.
- Derate linearly above $25^\circ C$ free-air temperature at a rate of $0.7 \text{ mA}/^\circ C$.
- Derate linearly above $25^\circ C$ free-air temperature at a rate of $2.0 \text{ mW}/^\circ C$.
- DC CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_o , to the forward LED input current, I_f , times 100%.
- Pin 7 Open.
- Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
- Use of a resistor between pin 5 and 7 will decrease gain and delay time.
- Common mode transient immunity in Logic High level is the maximum tolerable (positive) dv_{cm}/dt on the leading edge of the common mode pulse, V_{cm} , to assure that the output will remain in a Logic High state (i.e., $V_o > 2.0 V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) dv_{cm}/dt on the trailing edge of the common mode pulse signal, V_{cm} , to assure that the output will remain in a Logic Low state (i.e., $V_o < 0.8 V$).

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ C$ Unless Otherwise Specified)

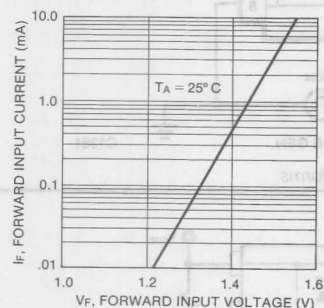


Fig. 1. Input Diode Forward Current vs. Forward Voltage

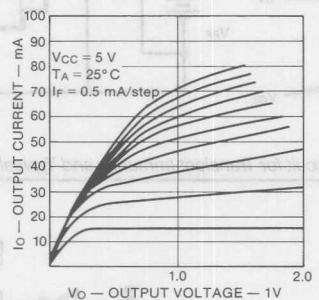


Fig. 2. 6N138/9 DC Transfer Characteristics

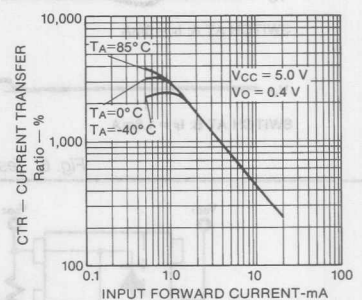


Fig. 3. Current Transfer Ratio vs. Input Forward Current

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

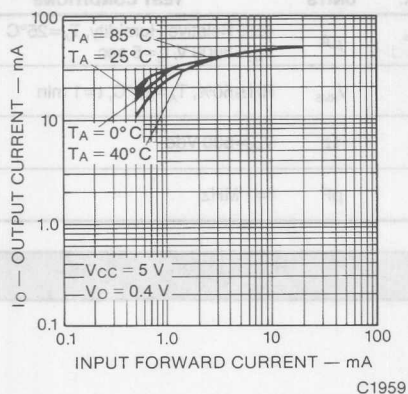


Fig. 4. 6N138 Output Current vs. Input Diode Forward Current

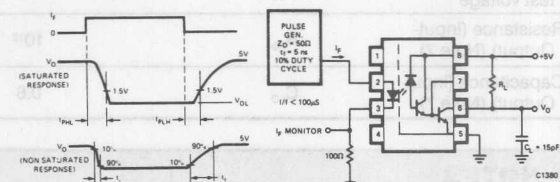


Fig. 5. Switching Test Circuit

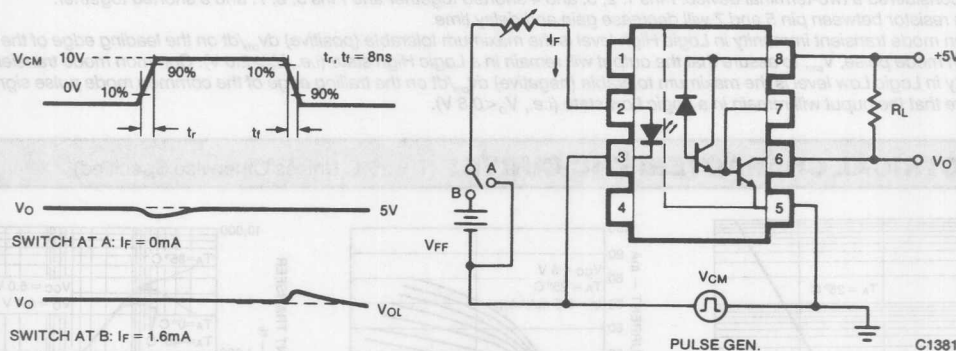
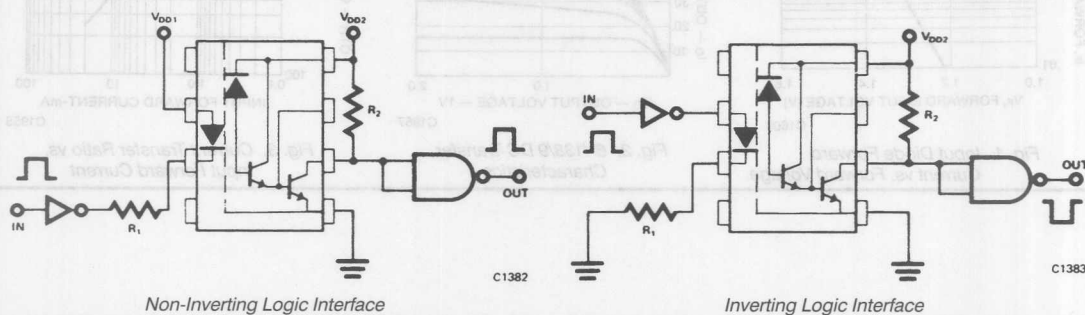


Fig. 6. Test Circuit for Transient Immunity and Typical Waveforms



ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

$$R_1 \text{ (NON-INVERT)} = \frac{V_{DD1} - V_{DF} - V_{OL1}}{I_F}$$

$$R_1 \text{ (INVERT)} = \frac{V_{DD1} - V_{OH1} - V_{DF}}{I_F}$$

$$R_2 = \frac{V_{DD2} - V_{OLX} (@I_L + I_2)}{I_L}$$

WHERE: V_{DD1} : INPUT SUPPLY VOLTAGE
 V_{DD2} : OUTPUT SUPPLY VOLTAGE
 V_{DF} : DIODE FORWARD VOLTAGE
 V_{OL1} : LOGIC "0" VOLTAGE OF DRIVER
 V_{OH1} : LOGIC "1" VOLTAGE OF DRIVER
 I_F : DIODE FORWARD CURRENT
 V_{OLX} : SATURATION VOLTAGE OF MCC670
 I_L : LOAD CURRENT THROUGH RESISTOR R_2
 I_2 : INPUT CURRENT OF OUTPUT GATE.

Current Limiting Resistor Calculation

		OUTPUT						
		CMOS @ 5V	CMOS @ 10V	74XX	74LXX	74SXX	74LSXX	74HXX
INPUT		$R_1 (\Omega)$	$R_2 (\Omega)$	$R_2 (\Omega)$	$R_2 (\Omega)$	$R_2 (\Omega)$	$R_2 (\Omega)$	$R_2 (\Omega)$
CMOS @ 5V	NON-INV.	2000						
	INV.	510						
CMOS @ 10V	NON-INV.	5100						
	INV.	4700						
74XX	NON-INV.	2200						
	INV.	180						
74LXX	NON-INV.	1800	1000	2200	750	1000	1000	560
	INV.	100						
74SXX	NON-INV.	2000						
	INV.	360						
74LSXX	NON-INV.	2000						
	INV.	180						
74HXX	NON-INV.	2000						
	INV.	180						

Resistor Values for Logic Interface



LSTTL to	TTL BUFFER	74OL6000
	TTL INVERTER	74OL6001
	CMOS BUFFER	74OL6010
	CMOS INVERTER	74OL6011

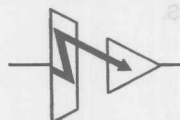
ORDER INFORMATION

PART NUMBER	LOGIC COMPATIBILITY		LOGIC FUNCTION	OUTPUT CONFIGURATION
	INPUT	OUTPUT		
74OL6000	LSTTL	TTL	BUFFER	TOTEM POLE
74OL6001	LSTTL	TTL	INVERTER	TOTEM POLE
74OL6010	LSTTL	CMOS	BUFFER	OPEN COLLECTOR
74OL6011	LSTTL	CMOS	INVERTER	OPEN COLLECTOR

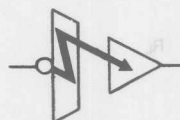
FEATURES

- Industry first LSTTL to TTL and LSTTL to CMOS complete logic-to-logic optocoupler
- Incorporates LED drive circuitry—use as logic gate
- Very high speed
- Choice of buffer or inverter
- Choice of TTL or CMOS compatible output up to 15 volts
- Fan-out of 10 TTL loads, fan-in 1 LSTTL load
- Internal noise shield—very high CMR of ± 15 kV/ μ s
- Provides superior 5300 VRMS Withstand Test Voltage (WTV)—guarantees 480 VAC operation
- Compact 6-pin DIP
- UL recognized (File #E90700)
- Same noise immunity as LSTTL/TTL.

SYMBOL



Buffer



Inverter

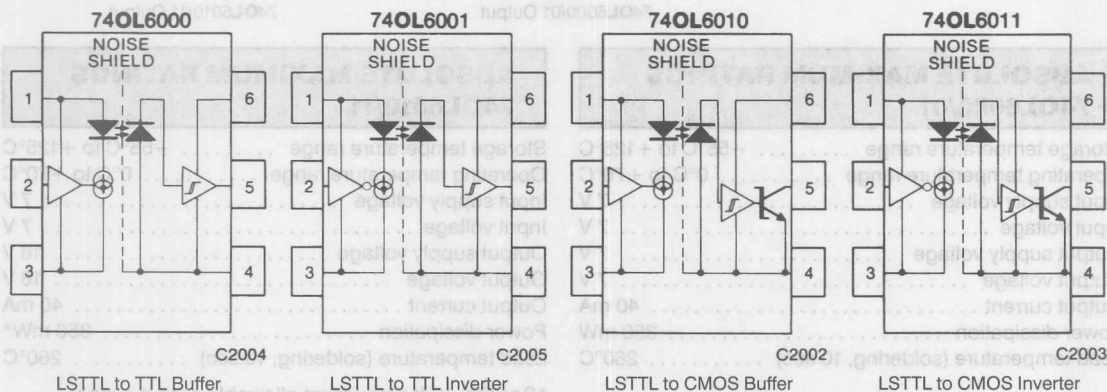
APPLICATIONS

- Transmission line interface—receiver and driver
- Excellent as bridged receiver in fast LAN highways
- Bus interface
- Logic family interface with ground loop noise elimination
- High speed AC/DC voltage sensing
- Driver for power semiconductor devices
- Level shifting
- Replaces fast pulse transformers

PIN CONFIGURATION

- | | |
|--------------------------------|---------------------------------|
| 1— V_{CCI} (Input V_{CC}) | 6— V_{CCO} (Output V_{CC}) |
| 2— V_{IN} (Data in) | 5— V_O (Data out) |
| 3—GND _I (Input GND) | 4—GND _O (Output GND) |

EQUIVALENT CIRCUITS



DESCRIPTION

OPTOLOGIC™ is the first family of truly logic compatible optically coupled logic interface gates.

The family consists of four device types offering LSTTL to TTL and LSTTL to CMOS interfacing. Each of these interfacing functions is available as a buffer ($A=B$), or as an inverter ($A=\overline{B}$).

The LSTTL input compatibility is provided by an input integrated circuit, with industry standard logic levels. This input amplifier IC switches a temperature compensated current source driving a high speed GaAsP/GaAs 700 nm LED emitter.

This novel integration scheme eliminates CTR degradation over time and temperature.

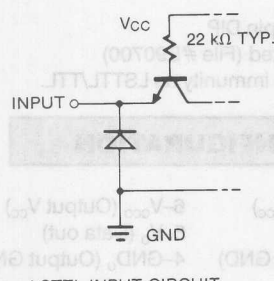
The emitter is optically coupled to an integrated photodetector/high-gain, high-speed output amplifier IC. The superior $15 \text{ kV}/\mu\text{s}$ common-mode noise rejection is ensured through the use of an optically transparent noise shield.

The TTL compatible output has a totem-pole with a fan-out of 10. The CMOS compatible output has an open collector Schottky-clamped transistor that interfaces to any CMOS logic between 4.5 and 15 volts.

The 74OL6010/11 may also be used to drive power MOS FETS or transistors up to 15 volts.

The Optologic coupler family typically offers propagation of delays of 60 ns and can support 15 Mbaud data communication.

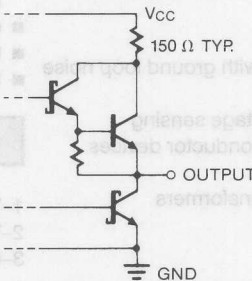
The two input chips and the output chip are assembled in a 6-pin DIP high insulation voltage plastic package. It provides a withstand test voltage of 5300 VRMS (1 minute), which is recognized as a working voltage of 480 VRMS.



LSTTL INPUT CIRCUIT

C2010

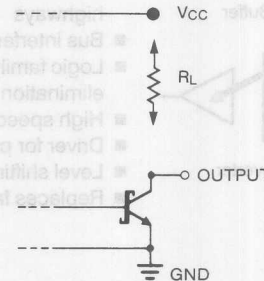
All Inputs



TTL OUTPUT CIRCUIT

C2009

74OL6000/01 Output



CMOS OUTPUT CIRCUIT

C2026

74OL6010/11 Output

ABSOLUTE MAXIMUM RATINGS 74OL6000/01

Storage temperature range	−55°C to +125°C
Operating temperature range	0°C to +70°C
Input supply voltage	7 V
Input voltage	7 V
Output supply voltage	7 V
Output voltage	7 V
Output current	40 mA
Power dissipation	350 mW
Lead temperature (soldering, 10 sec)	260°C

ABSOLUTE MAXIMUM RATINGS 74OL6010/11

Storage temperature range	−55°C to +125°C
Operating temperature range	0°C to +70°C
Input supply voltage	7 V
Input voltage	7 V
Output supply voltage	18 V
Output voltage	18 V
Output current	40 mA
Power dissipation	350 mW*
Lead temperature (soldering, 10 sec)	260°C

*See Fig. 12 for maximum allowable output supply voltage.

ELECTRICAL CHARACTERISTICS ($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

PARAMETER	SYM	MIN	TYP*	MAX	UNITS	TEST CONDITIONS			FIG.	NOTES
						74OL6000	74OL6001	74OL6000/01		
TTL OUTPUT 74OL6000/01										
Input supply voltage	V _{CCI}	4.5	5.0	5.5	V					1
Output supply voltage	V _{CCO}	4.5	5.0	5.5	V					1
High-level input voltage	V _{IH}	2.0			V					1
Low-level input voltage	V _{IL}			0.8	V					1
Input clamp voltage	V _{IK}			-1.2	V			V _{CCI} =4.5 V, I _i = -18 mA		1
High-level input current	I _{IH}		1.0	40.0	μA			V _{CCI} =5.5 V, V _{IH} =4.5 V		1
Low-level input current	I _{IL}		-200.0	-400.0	μA			V _{CCI} =5.5 V, V _{IL} =0.4 V		1
Input supply current (high)	I _{CCIH}		10.0	14.0	mA			V _{CCI} =5.5 V, V _{IN} =V _{IH}		1
Input supply current (low)	I _{CCIL}		10.0	14.0	mA			V _{CCI} =5.5 V, V _{IN} =V _{IL}		1
High-level output voltage	V _{OH}	2.4	3.0		V	V _{IN} =2.0 V	V _{IN} =0.8 V	V _{CCI} =4.5 V, V _{CCO} =4.5 V, I _{OH} = -400 μA		1
Low-level output voltage	V _{OL}	0.3	0.6		V	V _{IN} =0.8 V	V _{IN} =2.0 V	V _{CCI} =4.5 V, V _{CCO} =4.5 V, I _{OL} =16 mA		1
			0.5		V			V _{CCI} =4.5 V, V _{CCO} =4.5 V, I _{OL} =4 mA		1
High-level output current	I _{OH}	-8.0	-10.0		mA	V _{IN} =V _{IH}	V _{IN} =V _{IL}	V _{CCI} =4.5 V, V _{CCO} =4.5 V, V _{OH} =2.4 V		1
Low-level output current	I _{OL}	16.0			mA	V _{IN} =0.8 V	V _{IN} =2.0 V	V _{CCI} =4.5 V, V _{CCO} =4.5 V, V _{OL} =0.6 V		1
Short-circuit output current	I _{OS}	-5.0	-25.0	-40.0	mA	V _{IN} =V _{IH}	V _{IN} =V _{IL}	V _{CCI} =5.5 V, V _{CCO} =5.5 V		1
Output supply current (high)	I _{CCOH}		9.0	15.0	mA	V _{IN} =V _{IH}	V _{IN} =V _{IL}	V _{CCI} =5.5 V, V _O =V _{OH} , V _{CCO} =5.5 V		1
Output supply current (low)	I _{CCOL}		8.0	12.0	mA	V _{IN} =V _{IL}	V _{IN} =V _{IH}	V _{CCI} =5.5 V, V _O =V _{OL} , V _{CCO} =5.5 V		1

*All typical values are at $T_A=25^\circ\text{C}$

SWITCHING CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYM	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTES
TTL OUTPUT 74OL6000/01								
Propagation delay time for output low level	t_{PHL}		60	100	ns	$V_{CCI}=5\text{ V}, V_{CCO}=5\text{ V}$	15, 17	1
Propagation delay time for output high level	t_{PLH}		70	100	ns		15, 17	1
Output rise time for output high level	t_r		45		ns		15, 17	1
Output fall time for output low level	t_f		5		ns		15, 17	1

ELECTRICAL CHARACTERISTICS ($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

PARAMETER	SYM	MIN	TYP*	MAX	UNITS	TEST CONDITIONS			FIG.	NOTES	
						74OL6010	74OL6011	74OL6010/11			
CMOS OUTPUT 74OL6010/11											
Input supply voltage	V _{CCI}	4.5	5.0	5.5	V	V	5.5	5.0	4.5	V _{CCI}	1
Output supply voltage	V _{CCO}	4.5		15.0	V	V	5.5	5.0	4.5	V _{CCO}	1, 3
High-level input voltage	V _{IH}	2.0			V	V			2.0	V _{IH}	1
Low-level input voltage	V _{IL}			0.8	V	V	0.8			V _{IL}	1
Input clamp voltage	V _{IK}			-1.2	V	V	-1.5		V _{CCI} =4.5 V, I _I = -18 mA	V _{IK}	1
High-level input current	I _{IH}		1.0	40.0	μA	A _{IH}	0.05		V _{CCI} =5.5 V, V _{IH} =4.5 V	I _{IH}	1
Low-level input current	I _{IL}		-200.0	-400.0	μA	A _{IL}	0.05	0.1	V _{CCI} =5.5 V, V _{IL} =0.4 V	I _{IL}	1
Input supply current (high)	I _{CCIH}		10.0	14.0	mA	A _{CCIH}	0.1		V _{CCI} =5.5 V, V _{IN} =V _{IH}	I _{CCIH}	1
Input supply current (low)	I _{CCIL}		10.0	14.0	mA	A _{CCIL}	0.1	0	V _{CCI} =5.5 V, V _{IN} =V _{IL}	I _{CCIL}	1
Low-level output voltage	V _{OL}	0.4	0.6		V	V _{IN} =0.8 V	V _{IN} =2.0 V	V _{CCI} =4.5 V, V _{CCO} =4.5 V, I _{OL} =16 mA		High-level output voltage	1
			0.5		V			V _{CCI} =4.5 V, V _{CCO} =4.5 V, I _{OL} =4 mA	Low-level output voltage		
High-level output current	I _{OH}		1.0	100.0	μA	V _{IN} =V _{IH}	V _{IN} =V _{IL}	V _{CCI} =4.5 V, V _{OH} =15 V, V _{CCO} =4.5 - 15 V		I _{OH}	1
Low-level output current	I _{OL}	16.0			mA	V _{IN} =0.8 V	V _{IN} =2.0 V	V _{CCI} =4.5 V, V _{OL} =0.6 V, V _{CCO} =4.5 - 15 V		I _{OL}	1
Output supply current (high)	I _{CCOH}	9.0	12.0		mA	V _{IN} =V _{IH}	V _{IN} =V _{IL}	V _{CCI} =5.5 V, V _O =V _{OH} , V _{CCO} =4.5 V		Low-level output current	1
		11.0	18.0		mA			V _{CCI} =5.5 V, V _O =V _{OH} , V _{CCO} =15 V		Short-circuit output current	
Output supply current (low)	I _{CCOL}	8.0	12.0		mA	V _{IN} =V _{IL}	V _{IN} =V _{IH}	V _{CCI} =5.5 V, V _O =V _{OL} , V _{CCO} =4.5 V		Output supply current (high)	1
		11.0	18.0		mA			V _{CCI} =5.5 V, V _O =V _{OL} , V _{CCO} =15 V		Output supply current (low)	

*All typical values are at $T_A = 25^\circ\text{C}$

SWITCHING CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYM	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTES
TTL OUTPUT 74OL6010/11								
Propagation delay time for output low level	t_{PHL}		60	120	ns	$V_{CCI} = 5\text{ V}, V_{CCO} = 5\text{ V}, R_L = 470\ \Omega$	15, 18	1
Propagation delay time for output high level	t_{PLH}		100	180	ns		15, 18	1
Output rise time for output high level	t_r		50		ns		15, 18	1
Output fall time for output low level	t_f		5		ns		15, 18	1

ELECTRICAL CHARACTERISTICS ($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTES
74OL6000/01/10/11								
Common mode transient immunity at logic high level output	CM_H	5000	15000		V/ μs	$V_{CCI} = 5\text{ V}, V_{CCO} = 5\text{ V}, V_{CM} = 50\text{ V}_{PP}$	16, 19	
Common mode transient immunity at logic low level output	CM_L	-5000	-15000		V/ μs		16, 19	
Common mode coupling capacitance	C_{CM}		0.005		pF			
Capacitance (input-output)	C_{I-O}		0.7		pF	$V_{IO} = 0, f = 1\text{ MHz}$	2	
Withstand insulation test voltage	V_{ISO}	5300			VRMS	$T_A = 25^\circ\text{C}, t = 1\text{ min}, I_{IO} \leq 1\text{ }\mu\text{A}$	2	
Insulation resistance	R_{ISO}		10^{11}		Ω	$V_{IO} = 500\text{ VDC}$	2	

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

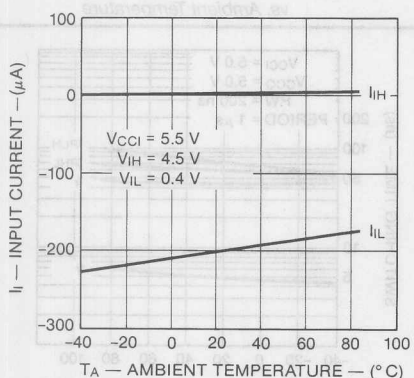


Fig. 1. Input Current vs. Ambient Temperature

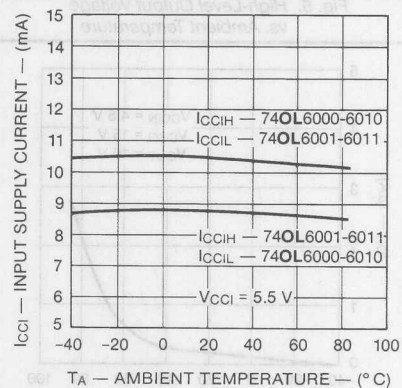


Fig. 2. Input Supply Current vs. Ambient Temperature

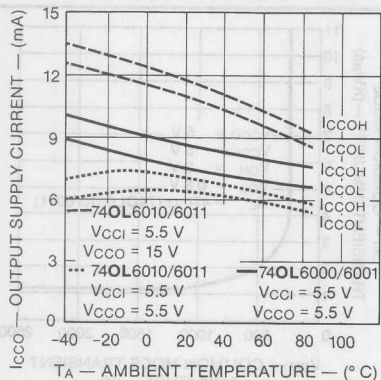


Fig. 3. Output Supply Current vs. Ambient Temperature

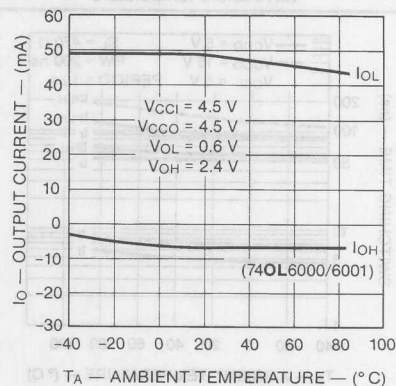


Fig. 4. Output Current vs. Ambient Temperature

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

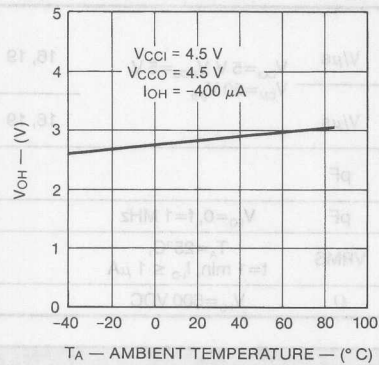


Fig. 5. High-Level Output Voltage vs. Ambient Temperature

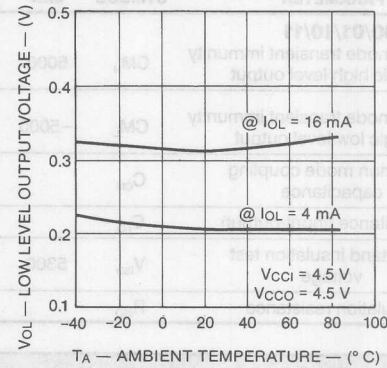


Fig. 6. Low-Level Output Voltage vs. Ambient Temperature

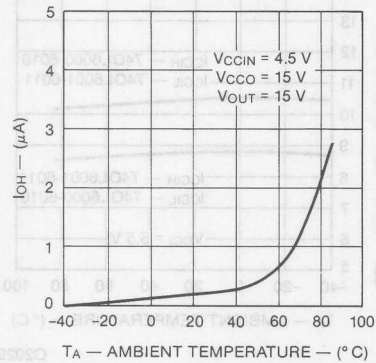


Fig. 7. 74OL6010/11 Leakage Current vs. Ambient Temperature

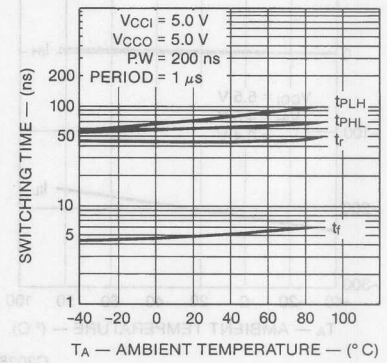


Fig. 8. 74OL6000/01 Switching Times vs. Ambient Temperature

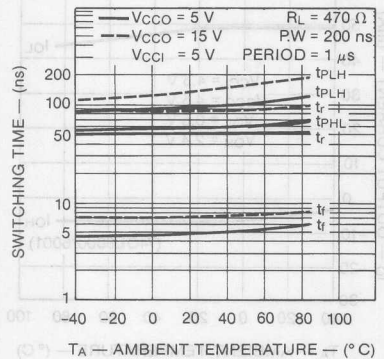


Fig. 9. 74OL6010/11 Switching Times vs. Ambient Temperature

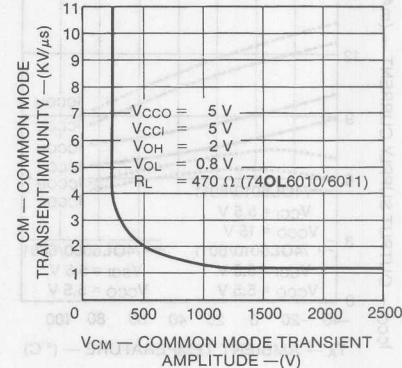


Fig. 10. Common Mode Rejection vs. Common Mode Voltage

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

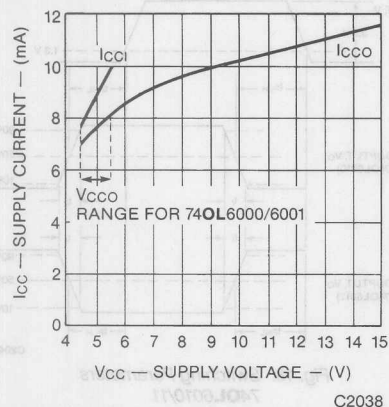


Fig. 11. Supply Current vs. Supply Voltage

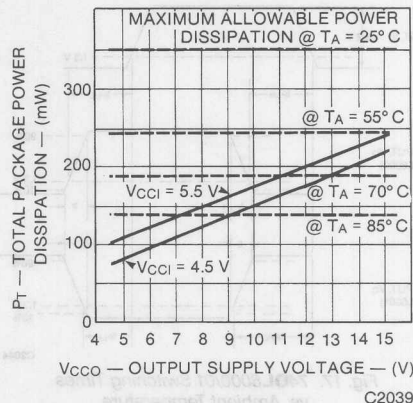


Fig. 12. Power Dissipation vs. Ambient Temperature

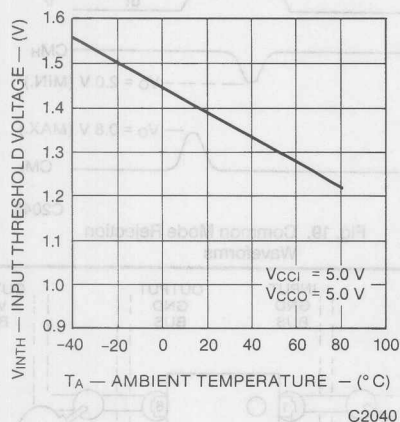


Fig. 13. Input Threshold Voltage vs. Ambient Temperature

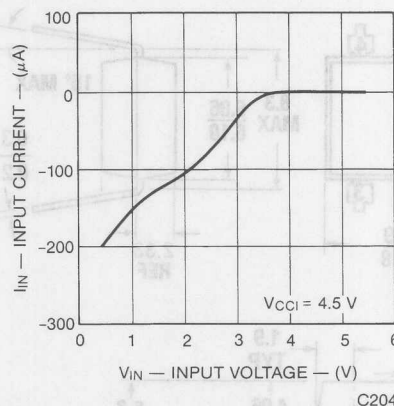


Fig. 14. Input Current vs. Input Voltage

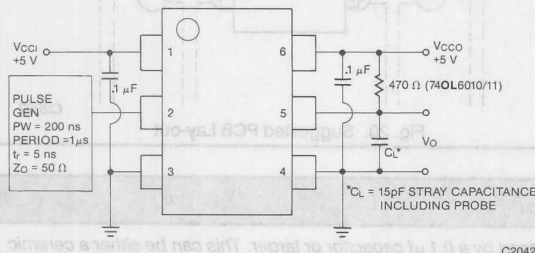


Fig. 15. Switching Time Test Circuit

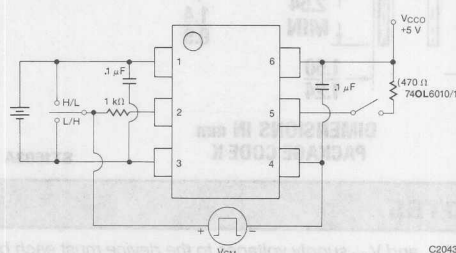


Fig. 16. Common Mode Rejection Test Circuit

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

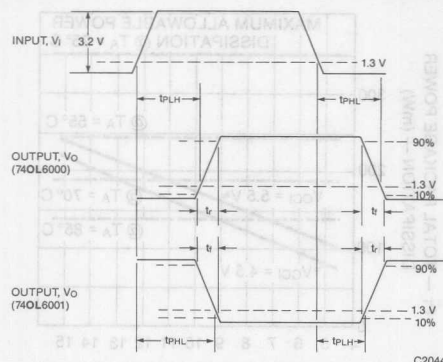


Fig. 17. 74OL6000/01 Switching Times vs. Ambient Temperature

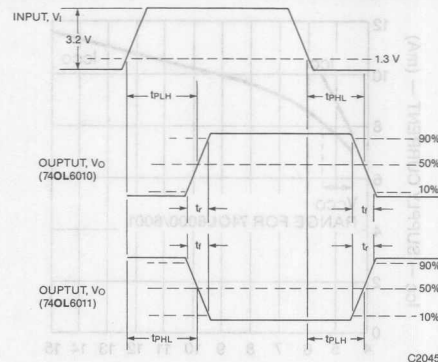
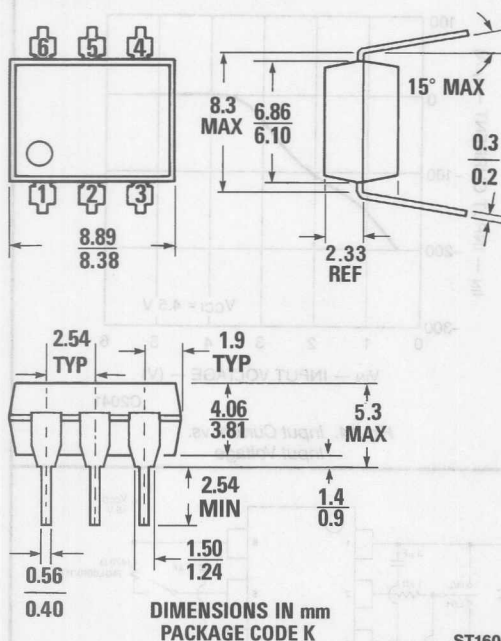


Fig. 18. Switching Parameters 74OL6010/11

PACKAGE DIMENSIONS



ST1603A

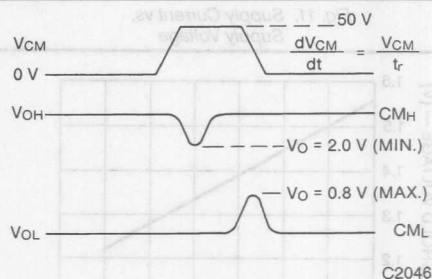


Fig. 19. Common Mode Rejection Waveforms

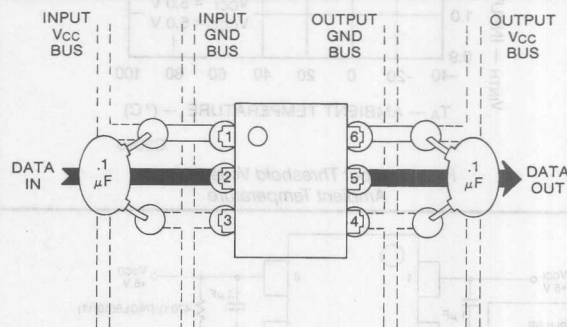
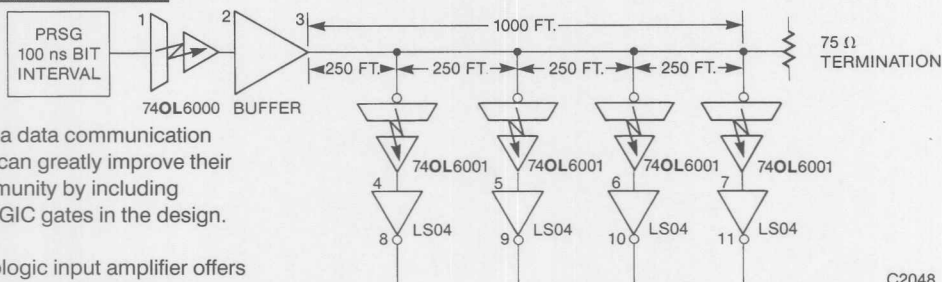


Fig. 20. Suggested PCB Lay-out

NOTES

1. The V_{CCO} and V_{CCI} supply voltages to the device must each be bypassed by a $0.1 \mu\text{F}$ capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristics. Its purpose is to stabilize the operation of the high-gain amplifiers. Failure to provide the bypass will impair the DC and switching properties. The total lead length between capacitor and optocoupler should not exceed 1.5mm. See Fig. 20.
2. Device considered a two-terminal device: Pins 1, 2 and 3 shorted together, and Pins 4, 5 and 6 shorted together.
3. For example, assuming a V_{CCI} of 5.0 V, and an ambient temperature of 70°C , the maximum allowable V_{CCO} is 12.1 V.

APPLICATION



Local area data communication systems can greatly improve their noise immunity by including OPTOLOGIC gates in the design.

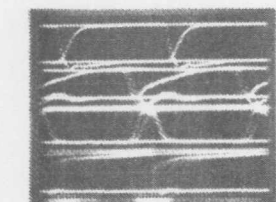
The Optologic input amplifier offers the feature of very high input impedance that permits their use as bridged line receivers. The system shown above illustrates an optically isolated transmitter and multidrop receiver system. The network uses a 74OL6000 and buffer (Figure D) to isolate the transmitter and drive the 75Ω coax cable. This application uses a 1000 ft. aerial suspension 75Ω CATV coax cable with data taps at 250 ft. intervals. The 74OL6001s function as bridged receivers, and as many as 30 receivers could be placed along the line with minimal

signal degradation. The communication cable is terminated with a single 75Ω load at the far end of the line.

Signal quality "Eye Pattern" is shown in Figures A, B and C with a 10MBaud NRZ Psuedo-Random Sequence (PRS). Traces 1-3 in Figure A describes the transmitter section. Traces 4-7 in Figure B show the output of the four Optologic bridged terminations. Traces 8-11 in Figure C illustrate "Eye Pattern" as

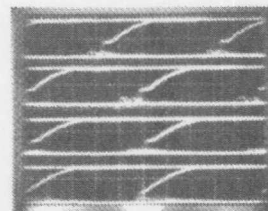
seen at the output of a 74LS04 logic gate. The data quality is well preserved in that only a 30% Eye closure is seen at the receiver located 1000 ft. from the transmitter.

The data communication system is completely optically isolated from all of the terminal equipments. Power for the transmitter (V_{CC}) and receiver (V_{CC}) is taken from an isolated power supply and distributed through a drain or messenger wire.



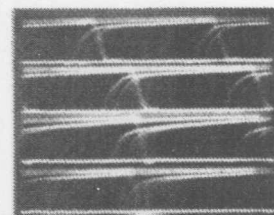
HORIZONTAL=20 ns/DIV
VERTICAL=2 V/DIV
42-11

Figure A



HORIZONTAL=20 ns/DIV
VERTICAL=2 V/DIV
42-12,02

Figure B



HORIZONTAL=20 ns/DIV
VERTICAL=2 V/DIV
42-13,03

Figure C

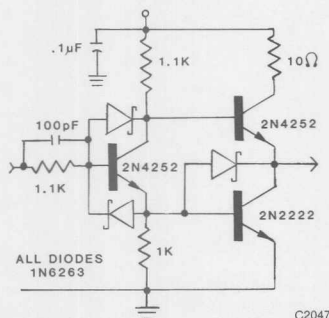


Figure D Buffer

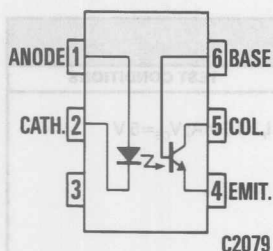
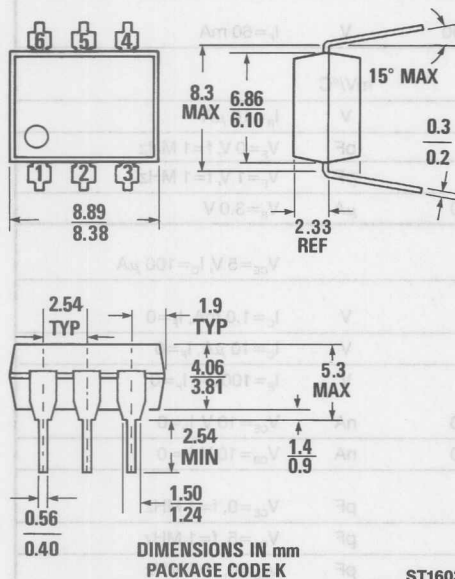
C2047

NOTES

- All Optologic Gate Input and Output Amplifiers Bypassed With 0.1 μ F Capacitors
- PRSG=Pseudo Random Sequence Generator
- 1 to 11 Refer To Testpoints; See Waveforms on Figs. A, B and C

**CNY17-1 CNY17-3
CNY17-2 CNY17-4**

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The CNY17 series consists of a Gallium Arsenide IRED coupled with an NPN phototransistor.

FEATURES

- High isolation voltage
5300 VAC RMS—1 minute
7500 VAC PEAK—1 minute
- High BV_{CEO} minimum 70 volts
- Current transfer ratio in selected groups:
CNY17-1: 40%- 80%
CNY17-2: 63%-125%
CNY17-3: 100%-200%
CNY17-4: 160%-320%
- Maximum switching time in saturation specified
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	—55°C to 150°C
Operating temperature	—55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	90 mA
Reverse voltage	6 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	135 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)**INDIVIDUAL COMPONENT CHARACTERISTICS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F=60$ mA
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	6.0	15		V	$I_R=10$ μ A
Junction capacitance	C_J		50		pF	$V_F=0$ V, $f=1$ MHz
			65		pF	$V_F=1$ V, $f=1$ MHz
Reverse leakage current	I_R		.35	10	μ A	$V_R=3.0$ V
OUTPUT TRANSISTOR						
DC forward current gain	h_{FE}	100	500			$V_{CE}=5$ V, $I_C=100$ μ A
Breakdown voltage Collector to emitter	BV_{CEO}	70			V	$I_C=1.0$ mA, $I_E=0$
Collector to base	BV_{CBO}	70			V	$I_C=10$ μ A, $I_E=0$
Emitter to collector	BV_{ECO}	7			V	$I_E=100$ μ A, $I_F=0$
Leakage current Collector to emitter	I_{CEO}		5	50	nA	$V_{CE}=10$ V, $I_F=0$
Collector to base	I_{CBO}			20	nA	$V_{CB}=10$ V, $I_F=0$
Capacitance Collector to emitter			8		pF	$V_{CE}=0$, $f=1$ MHz
Collector to base			20		pF	$V_{CB}=5$, $f=1$ MHz
Emitter to base			10		pF	$V_{EB}=0$, $f=1$ MHz

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio, collector to emitter CNY17-1	CTR				%	$I_F=10$ mA; $V_{CE}=5$ V
		40		80		
		63		125		
		100		200		
		160		320		
Saturation voltage	$V_{CE(SAT)}$		0.27	.40	V	$I_F=10$ mA; $I_C=2.5$ mA

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						$R_L=100$ Ω ; $I_C=2$ mA;
Turn-on time	t_{on}		6.0	10	μ s	$V_{CC}=10$ V
Turn-off time	t_{off}		5.5	10	μ s	See Fig. 10 and Fig. 11.

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Temperature Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS (Cont'd)

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SATURATED SWITCHING TIMES						
Turn-on time	t_{on}		3.0	5.5	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
	CNY17-1					
	CNY17-2, CNY17-3, CNY17-4		4.2	8.0	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Rise-time	t_r		2.0	4.0	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
	CNY17-1					
	CNY17-2, CNY17-3, CNY17-4		3.0	6.0	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Turn-off time	t_{off}		18	34	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
	CNY17-1					
	CNY17-2, CNY17-3, CNY17-4		23	39	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Fall-time	t_f		11	20	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
	CNY17-1					
	CNY17-2, CNY17-3, CNY17-4		14	24	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation Voltage	V_{iso}	5300			$V_{AC \text{ RMS}}$	$I_{FO} \leq 1 \mu A$, 1 minute
	V_{iso}	7500			$V_{AC \text{ PEAK}}$	$I_{FO} \leq 1 \mu A$, 1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{FO} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f = 1 \text{ MHz}$

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

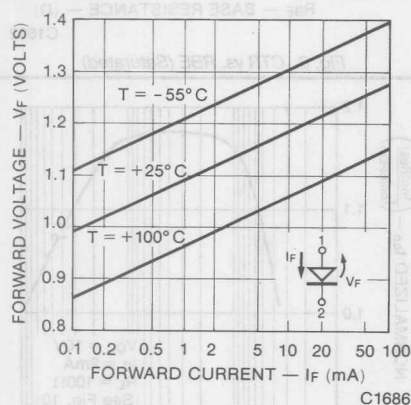


Fig. 1. Forward Voltage vs. Current

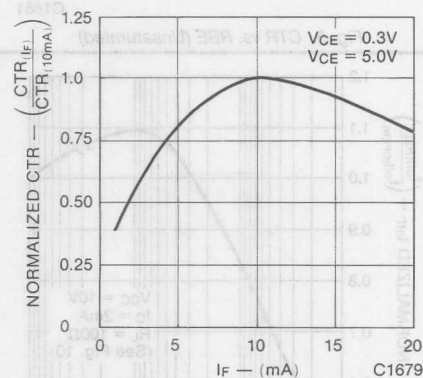


Fig. 2. Normalized CTR vs. Forward Current

CNY17-1 CNY17-2 CNY17-3 CNY17-4

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

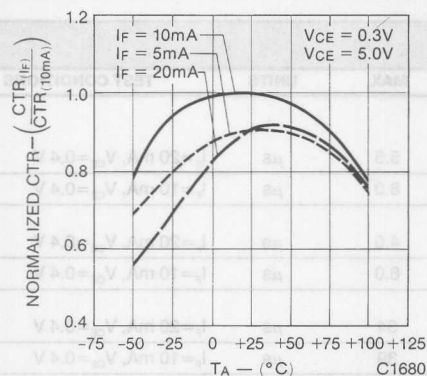


Fig. 3. Normalized CTR vs. Temperature

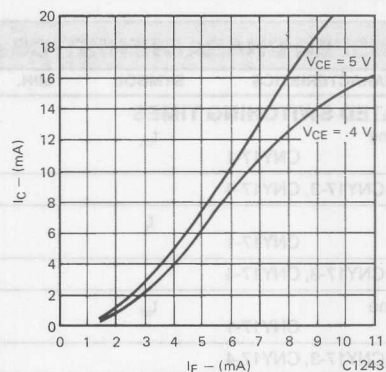


Fig. 4. Collector Current vs. Forward Current

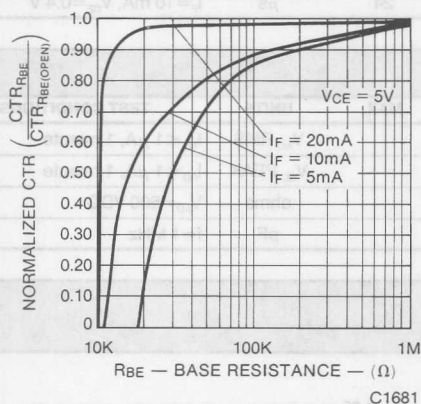


Fig. 5. CTR vs. RBE (Unsaturated)

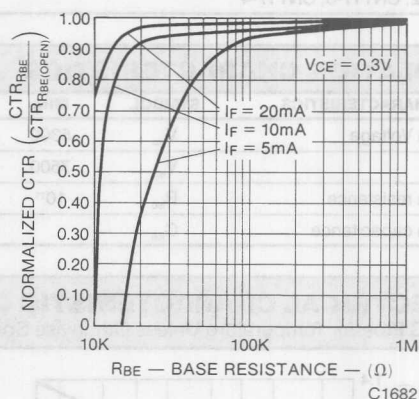


Fig. 6. CTR vs. RBE (Saturated)

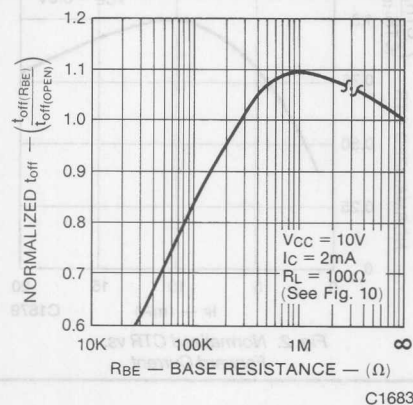


Fig. 7. Normalized T_{OFF} vs. RBE

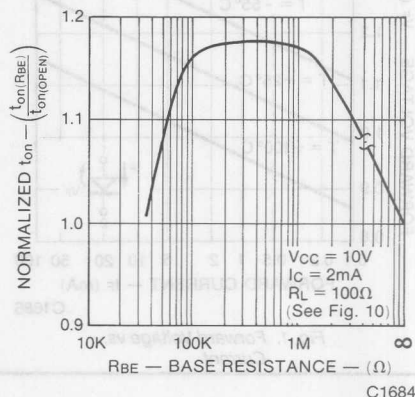


Fig. 8. Normalized T_{ON} vs. RBE

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

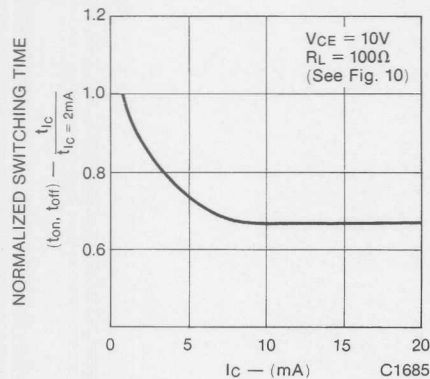


Fig. 9. Switching Time vs. I_C

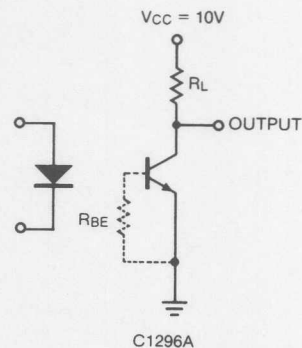


Fig. 10. Switching Time Test Circuit

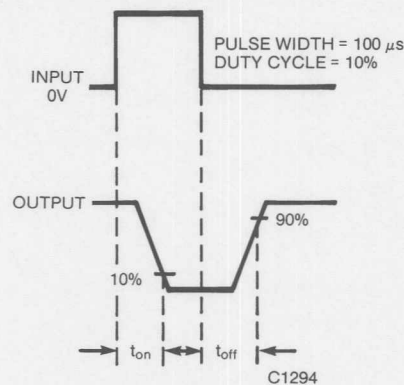


Fig. 11. Switching Time Waveforms

FIG. 11 Switching Time Waveforms

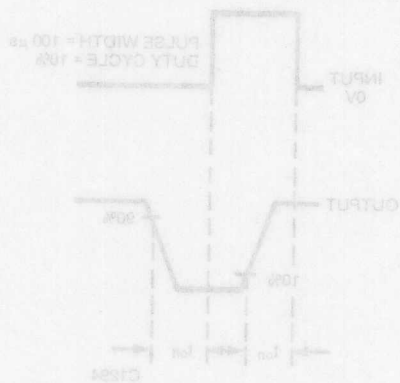


Fig. 8. Switching Time vs I_D

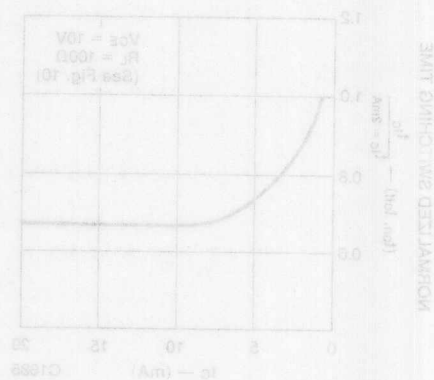
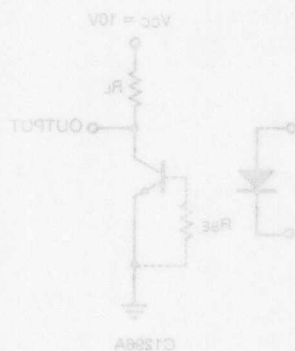


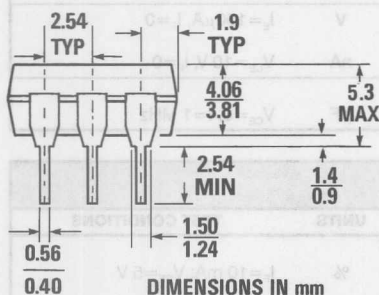
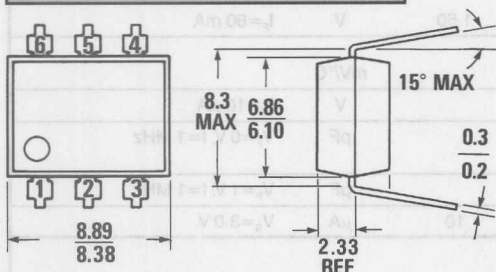
Fig. 10. Switching Time Test Circuit



CMOS CHARACTERISTICS

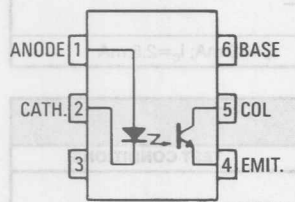
**CNY17F-1
CNY17F-2
CNY17F-3**

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



Equivalent Circuit

DESCRIPTION

The CNY17 series consists of a Gallium Arsenide IRED coupled with an NPN phototransistor.

FEATURES

- High isolation voltage
5300 VAC RMS—1 minute
7500 VAC PEAK—1 minute
- High BV_{CEO} minimum 70 volts
- Current transfer ratio in selected groups:
CNY17F1: 40%- 80%
CNY17F2: 63%-125%
CNY17F3: 100%-200%
- Maximum switching time in saturation specified
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	—55°C to 150°C
Operating temperature	—55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	90 mA
Reverse voltage	6 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	135 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F=60$ mA
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	6.0	15		V	$I_R=10$ μ A
Junction capacitance	C_J		50		pF	$V_F=0$ V, $f=1$ MHz
			65		pF	$V_F=1$ V, $f=1$ MHz
Reverse leakage current	I_R		.35	10	μ A	$V_R=3.0$ V
OUTPUT TRANSISTOR						
Breakdown voltage						
Collector to emitter	BV_{CEO}	70			V	$I_C=1.0$ mA, $I_F=0$
Emitter to collector	BV_{ECO}	7			V	$I_E=100$ μ A, $I_F=0$
Leakage current						
Collector to emitter	I_{CEO}		5	50	nA	$V_{CE}=10$ V, $I_F=0$
Capacitance						
Collector to emitter			8		pF	$V_{CE}=0$, $f=1$ MHz

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio, collector to emitter	CTR				%	$I_F=10$ mA; $V_{CE}=5$ V
CNY17F-1		40		80		
CNY17F-2		63		125		
CNY17F-3		100		200		
Saturation voltage	$V_{CE(SAT)}$		0.27	.40	V	$I_F=10$ mA; $I_C=2.5$ mA

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						$R_L=100$ Ω ; $I_C=2$ mA;
Turn-on time	t_{on}		6.0	10	μ s	$V_{CC}=10$ V
Turn-off time	t_{off}		5.5	10	μ s	See Fig. 10.

CNY17F-1 CNY17F-2 CNY17F-3

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Temperature Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS (Cont'd)

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SATURATED SWITCHING TIMES						
Turn-on time	t_{on}					
CNY17F-1			3.0	5.5	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
CNY17F-2, CNY17F-3			4.2	8.0	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Rise-time	t_r					
CNY17F-1			2.0	4.0	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
CNY17F-2, CNY17F-3			3.0	6.0	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Turn-off time	t_{off}					
CNY17F-1			18	34	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
CNY17F-2, CNY17F-3			23	39	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Fall-time	t_f					
CNY17F-1			11	20	μs	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
CNY17F-2, CNY17F-3			14	24	μs	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation Voltage	V_{iso}	5300			$V_{AC} \text{ RMS}$	$I_{FO} \leq 1 \mu A$, 1 minute
	V_{iso}	7500			$V_{AC} \text{ PEAK}$	$I_{FO} \leq 1 \mu A$, 1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{FO} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f = 1 \text{ MHz}$

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

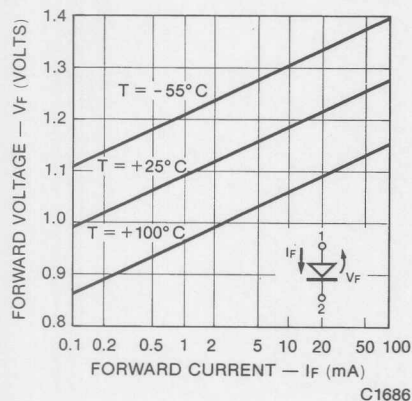


Fig. 1. Forward Voltage vs. Current

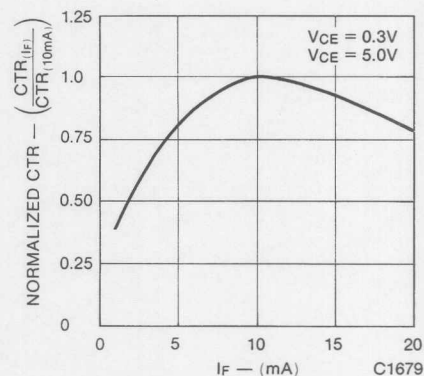


Fig. 2. Normalized CTR vs. Forward Current

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

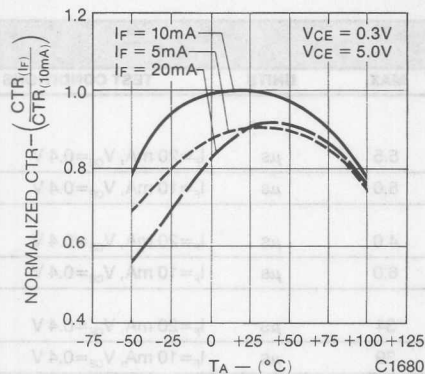


Fig. 3. Normalized CTR vs. Temperature

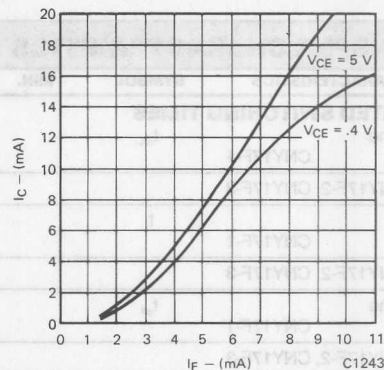
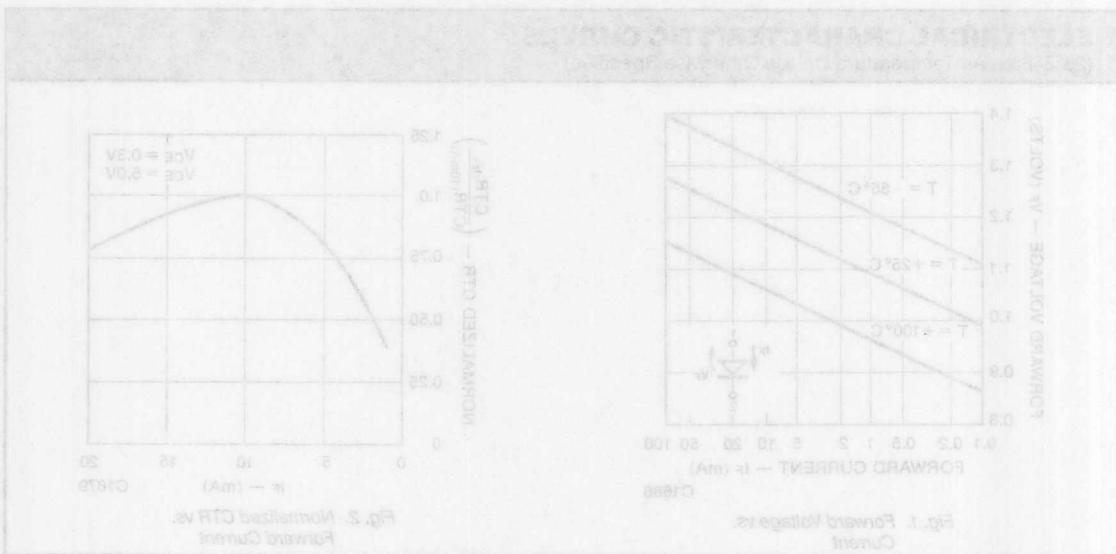


Fig. 4. Collector Current vs. Forward Current

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation Voltage	V_{iso}	500			V _{RMS}	$I_F < 1$ mA, 1 minute
Isolation Resistance	R_{iso}	10 ¹⁰			ohms	$V_{iso} = 500$ VDC
Isolation Capacitance	C_{iso}	0.8			pf	$f = 1$ MHz



ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

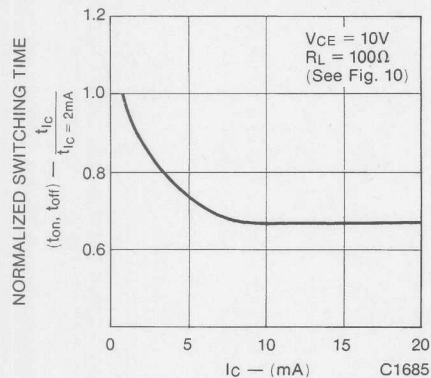


Fig. 5. Switching Time vs. I_C

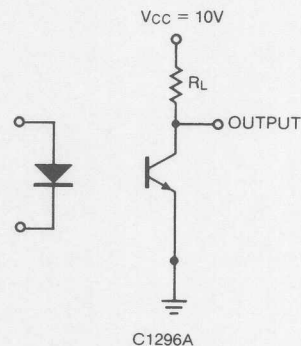


Fig. 6. Switching Time Test Circuit

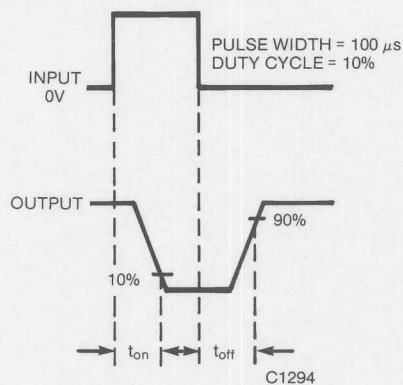
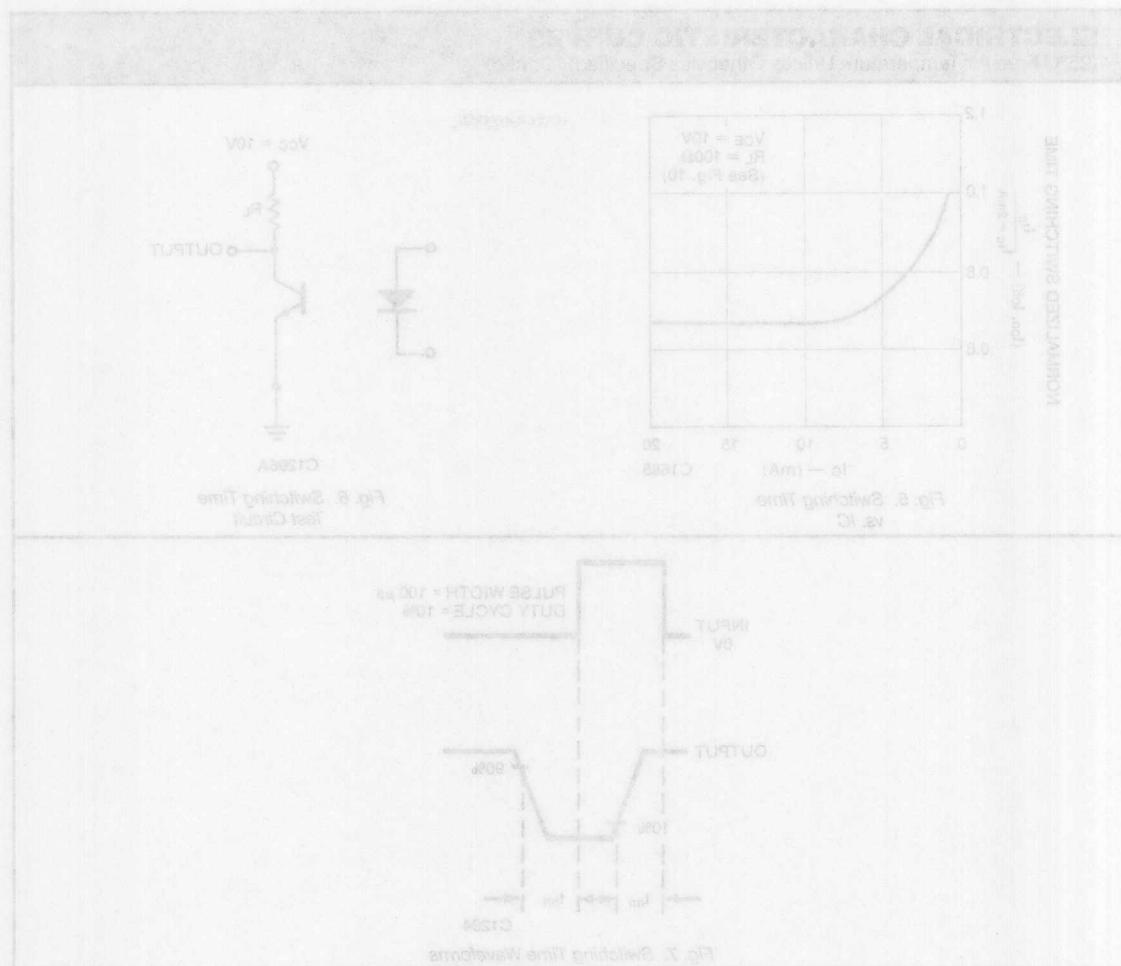
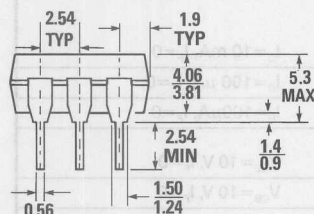
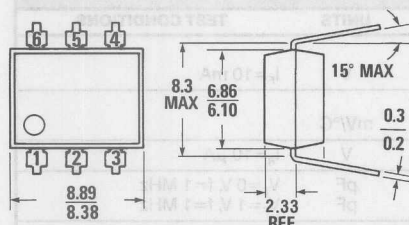


Fig. 7. Switching Time Waveforms



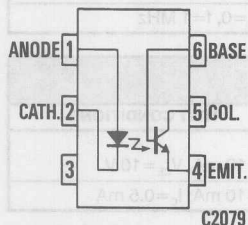
H11A1

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



Equivalent Circuit

DESCRIPTION

The H11A1 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor in a standard plastic six-pin dual-in-line package.

FEATURES

- High isolation voltage
5300 VAC RMS—1 minute
7500 VAC PEAK—1 minute
- Minimum current transfer ratio of 50%
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	6 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	150 mW
Derate linearly from 25°C	2.67 mW/°C
V_{CEO}	30 V
V_{CBO}	70 V
V_{ECO}	7 V
Collector current (continuous)	100 mA

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.1	1.50	V	$I_F = 10 \text{ mA}$
Forward voltage temperature coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	3.0	15		V	$I_R = 10 \mu\text{A}$
Junction capacitance	C_J		50 65		pF pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$ $V_F = 1 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0 \text{ V}$
OUTPUT TRANSISTOR						
Breakdown voltage						
Collector to emitter	BV_{CEO}	30	45		V	$I_C = 10 \text{ mA}, I_F = 0$
Collector to base	BV_{CBO}	70	130		V	$I_C = 100 \mu\text{A}, I_F = 0$
Emitter to collector	BV_{ECO}	7	10		V	$I_E = 100 \mu\text{A}, I_F = 0$
Leakage current						
Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10 \text{ V}, I_F = 0$
Collector to base	I_{CBO}			20	nA	$V_{CB} = 10 \text{ V}, I_F = 0$
Capacitance						
Collector to emitter			8		pF	$V_{CE} = 0, f = 1 \text{ MHz}$
Collector to base			20		pF	$V_{CB} = 5, f = 1 \text{ MHz}$
Emitter to base			10		pF	$V_{EB} = 0, f = 1 \text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio collector to emitter	CTR	50			%	$I_F = 10 \text{ mA}, V_{CE} = 10 \text{ V}$
Saturation voltage	$V_{CE(SAT)}$		0.1	0.4	V	$I_F = 10 \text{ mA}; I_C = 0.5 \text{ mA}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						$(V_{CE} = 10 \text{ V}, I_{CE} = 2 \text{ mA}, R_L = 100 \Omega)$
Turn-on time	t_{on}		2		μs	
Turn-off time	t_{off}		2		μs	See Fig. 10 and 11
Non-saturated						$(V_{CE} = 10 \text{ V}, I_{CE} = 50 \mu\text{A}, R_L = 100 \Omega)$
Turn-on time	t_{on}		300		ns	
Turn-off time	t_{off}		300		ns	See Fig. 10 and 11

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{ISO}	5300 7500			$V_{AC} \text{ RMS}$ $V_{AC} \text{ PEAK}$	$I_{I/O} \leq 1 \mu\text{A}, 1 \text{ minute}$ $I_{I/O} \leq 1 \mu\text{A}, 1 \text{ minute}$
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{I/O} = 500 \text{ VDC}$
Isolation capacitance	C_{ISO}		0.5		pF	$f = 1 \text{ MHz}$

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

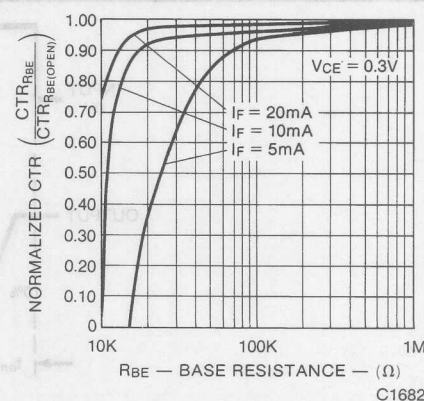
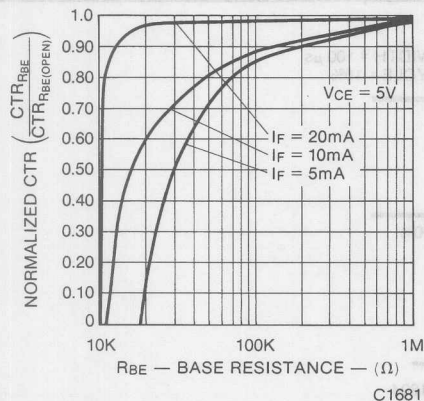
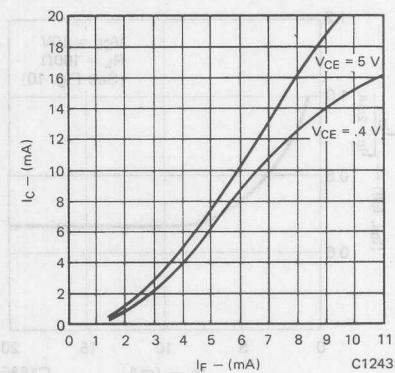
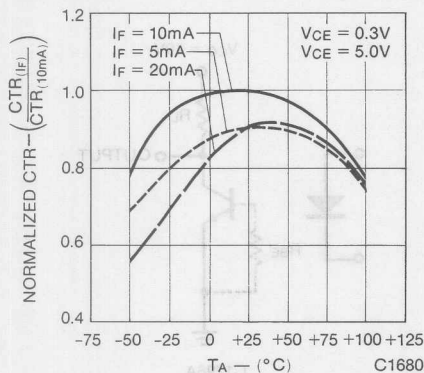
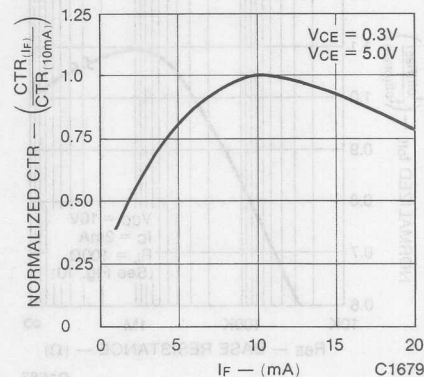
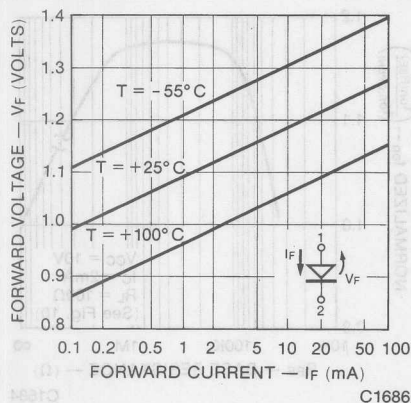


Fig. 5. CTR vs. RBE (Unsaturated)

Fig. 6. CTR vs. RBE (Saturated)

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

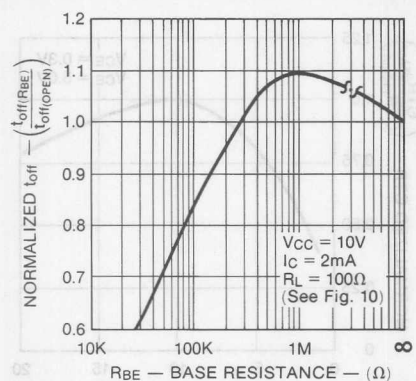


Fig. 7. Normalized T_{OFF} vs. R_{BE}

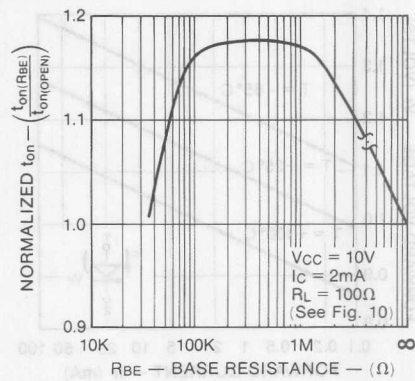


Fig. 8. Normalized T_{ON} vs. R_{BE}

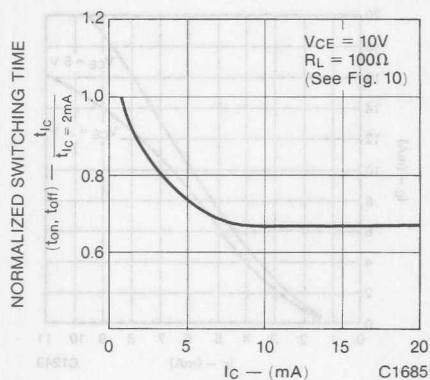


Fig. 9. Switching Time vs. I_C

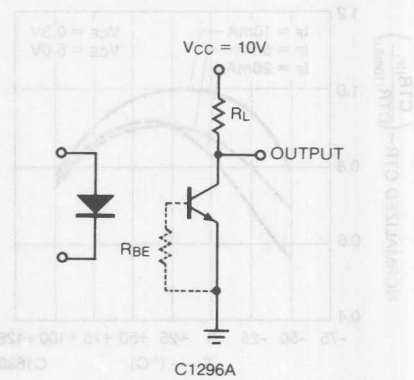


Fig. 10. Switching Time Test Circuit

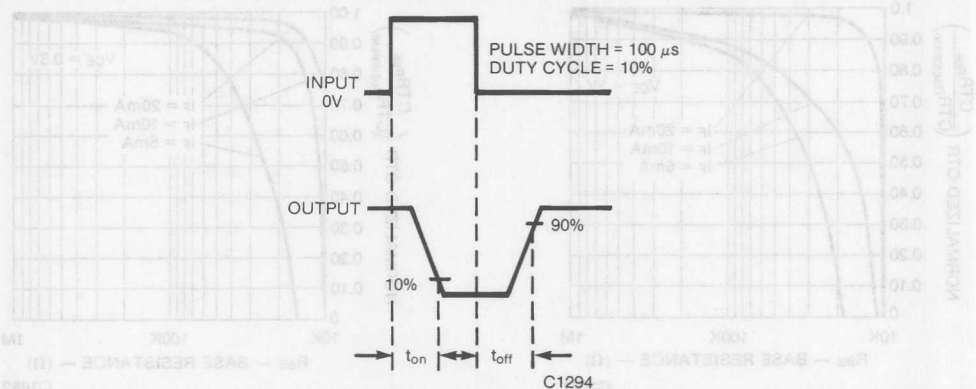
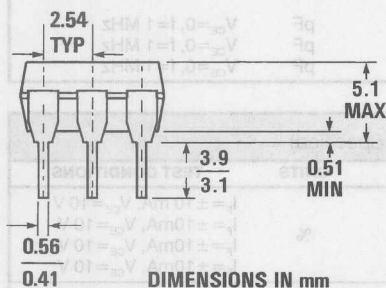
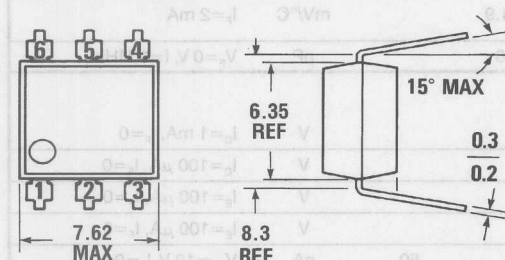


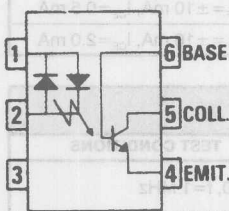
Fig. 11. Switching Time Waveforms

**H11AA1 H11AA3
H11AA2 H11AA4**

PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**



Equivalent Circuit

DESCRIPTION

The H11AAX family of devices has two GaAs emitters connected in inverse parallel driving a single silicon phototransistor output.

FEATURES

- Bi-polar emitter input
- Built-in reverse polarity input protection
- UL recognized (File #E90700)

APPLICATIONS

- AC line monitor
- Unknown polarity DC sensor
- Telephone line interface

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Power dissipation	350 mW
Derate linearly from 25°C	4.6 mW
Storage temperature	-55°C to 150°C
Operating temperature	-55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C

INPUT DIODE

Forward current	100 mA
Peak forward current (1 μ s pulse, 300 pps)	± 1.0 A
Power dissipation	200 mW
Derate linearly from 25°C	2.6 mW/°C

OUTPUT TRANSISTOR

Power dissipation	300 mW
Derate linearly from 25°C	4.0 mW/°C

INDIVIDUAL COMPONENT CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE							
Forward voltage	V_F	ALL		1.2	1.5	V	$I_F = \pm 10 \text{ mA}$
Forward voltage coefficient	$\Delta V_F / \Delta T_A$	ALL		-1.9		mV/ $^\circ\text{C}$	$I_F = 2 \text{ mA}$
Junction capacitance	C_J	ALL		80		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
OUTPUT TRANSISTOR							
Breakdown voltage							
Collector to emitter	BV_{CEO}	ALL	30			V	$I_C = 1 \text{ mA}, I_F = 0$
Collector to base	BV_{CBO}	ALL	70			V	$I_C = 100 \mu\text{A}, I_F = 0$
Emitter to base	BV_{EBO}	ALL	5			V	$I_E = 100 \mu\text{A}, I_F = 0$
Emitter to collector	BV_{ECO}	ALL	7			V	$I_E = 100 \mu\text{A}, I_F = 0$
Leakage current	I_{CEO}	H11AA1,3,4			50	nA	$V_{CE} = 10 \text{ V}, I_F = 0$
	I_{CEO}	H11AA2			200	nA	$V_{CE} = 10 \text{ V}, I_F = 0$
Capacitance							
Collector to emitter	C_{CE}	ALL		10		pF	$V_{CE} = 0, f = 1 \text{ MHz}$
Collector to base	C_{CB}	ALL		80		pF	$V_{CE} = 0, f = 1 \text{ MHz}$
Emitter to base	C_{EB}	ALL		15		pF	$V_{CE} = 0, f = 1 \text{ MHz}$

TRANSFER CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current transfer (Collector-Emitter)	CTR_{CE}	H11AA4	100			%	$I_F = \pm 10 \text{ mA}, V_{CE} = 10 \text{ V}$
		H11AA3	50				$I_F = \pm 10 \text{ mA}, V_{CE} = 10 \text{ V}$
		H11AA1	20				$I_F = \pm 10 \text{ mA}, V_{CE} = 10 \text{ V}$
		H11AA2	10				$I_F = \pm 10 \text{ mA}, V_{CE} = 10 \text{ V}$
Current transfer ratio symmetry		ALL	0.33		3.0		$I_F = \pm 10 \text{ mA}, V_{CE} = 10 \text{ V}$ Fig. 6
Saturation voltage (Collector-Emitter)	$V_{CE\text{SAT}}$	ALL			0.4	V	$I_F = \pm 10 \text{ mA}, I_{CE} = 0.5 \text{ mA}$
		H11AA3,4		0.4		V	$I_F = \pm 16 \text{ mA}, I_{CE} = 2.0 \text{ mA}$

ISOLATION CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Package capacitance input/output	$C_{i,o}$		0.7		pF	$V_{i,o} = 0, f = 1 \text{ MHz}$
Withstand insulation test voltage	V_{ISO}	5300			$V_{AC(RMS)}$	$I_{i,o} \leq 1 \mu\text{A}, 1 \text{ minute}$
Insulation resistance	R_{ISO}	10^{11}			Ohms	$V_{i,o} = 500 \text{ V}$

H11AA1 H11AA2 H11AA3 H11AA4

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

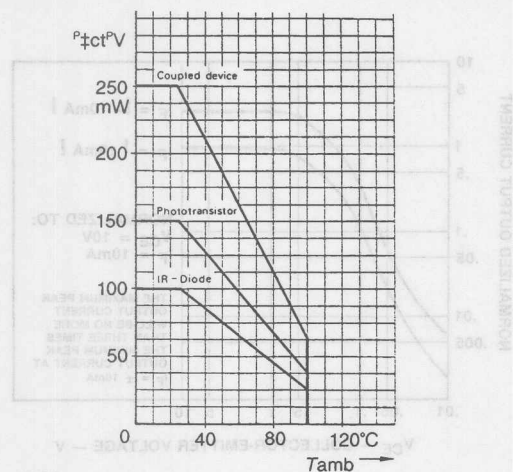


Fig. 1.

C2303

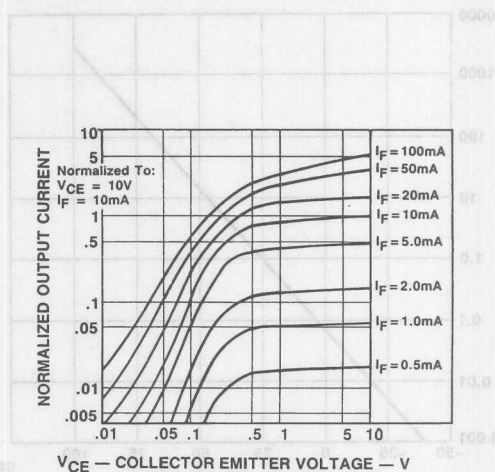


Fig. 2. Transfer Characteristics

C2309

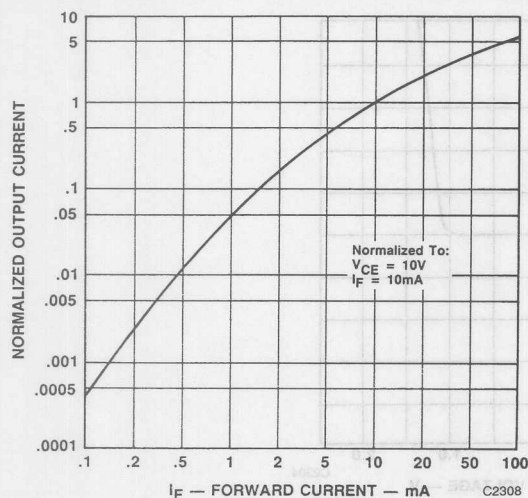


Fig. 3. Input Current vs.
Output Current

C2308

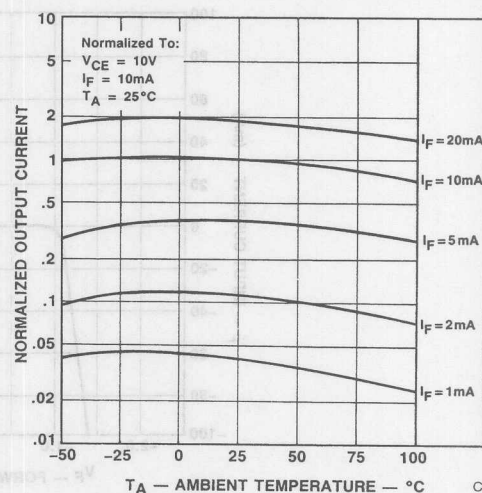


Fig. 4. Output Current vs.
Temperature

C2305

ELECTRICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

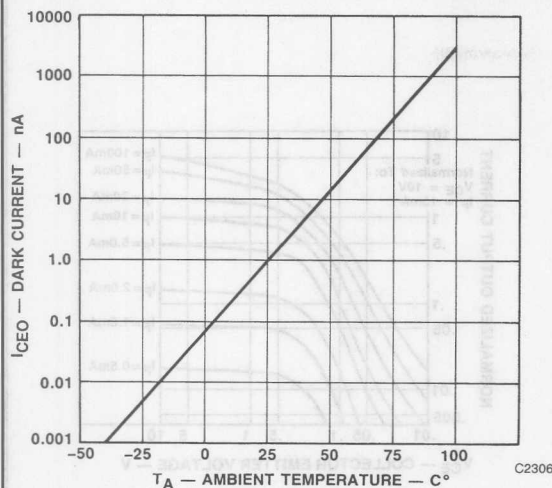


Fig. 5 Dark Current vs. Temperature

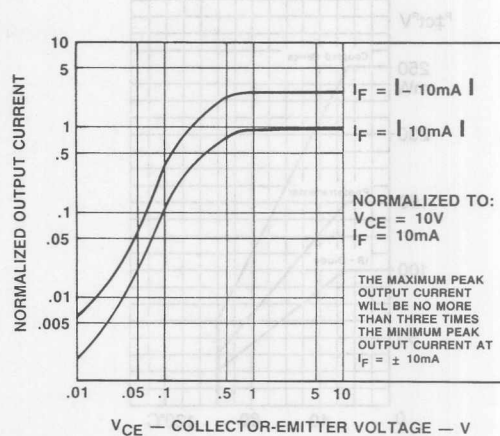


Fig. 6. Output Symmetry Characteristics

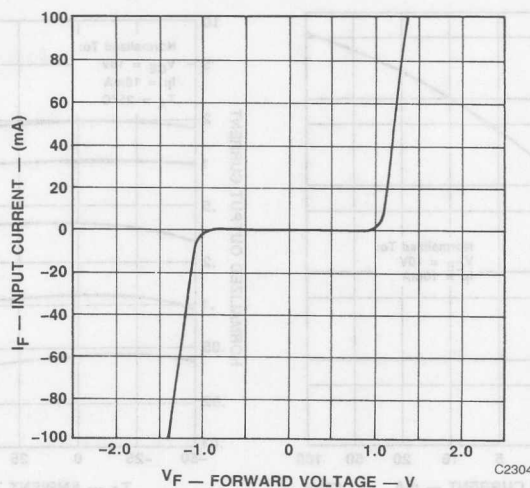
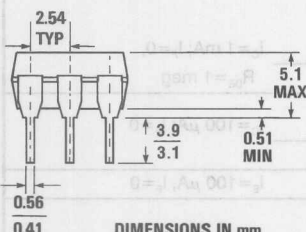
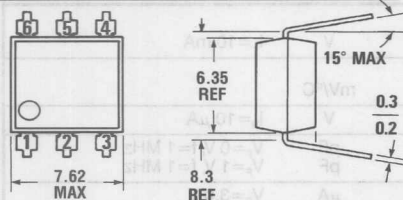


Fig. 7.

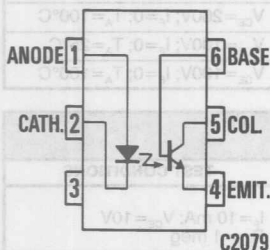
**H11D1 H11D2
H11D3**

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE E

ST1603-02



Equivalent Circuit

DESCRIPTION

The H11DX is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- High voltage
H11D1-D2, $BV_{CER}=300$ V
H11D3, $BV_{CER}=200$ V
- High isolation voltage
5300 VAC RMS—1 minute
7500 VAC PEAK—1 minute
- Minimum current transfer ratio of H11D1, H11D2, H11D3—20%
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation at 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	6 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation at 25°C	300 mW	
Derate linearly from 25°C	4.0 mW/°C	
	H11D1-D2 H11D3	
V _{CER}	300 V	200 V
V _{CBO}	300 V	200 V
V _{ECO}	6 V	6 V
Collector current (continuous)	100 mA	100 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.1	1.50	V	$I_F = 10\text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/ $^\circ\text{C}$	
Reverse breakdown voltage	V_R	3.0	25		V	$I_R = 10\text{ }\mu\text{A}$
Junction capacitance	C_J		50 65		pF pF	$V_F = 0\text{ V}, f = 1\text{ MHz}$ $V_F = 1\text{ V}, f = 1\text{ MHz}$
Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0\text{ V}$
OUTPUT TRANSISTOR						
Breakdown voltage						
Collector to emitter H11D1, H11D2,	BV_{CER}	300			V	$I_C = 1\text{ mA}; I_F = 0,$
H11D3		200			V	$R_{BE} = 1\text{ meg}$
Collector to base H11D1, H11D2,	BV_{CBO}	300			V	$I_C = 100\text{ }\mu\text{A}; I_F = 0$
H11D3		200			V	
Emitter to base	BV_{EBO}	5	7		V	$I_E = 100\text{ }\mu\text{A}, I_F = 0$
Leakage current Collector to emitter ($R_{BE} = 1\text{ meg.}$) H11D1, H11D2,	I_{CER}			100	nA	$V_{CE} = 200\text{ V}; I_F = 0; T_A = 25^\circ\text{C}$
				250	μA	$V_{CE} = 200\text{ V}; I_F = 0; T_A = 100^\circ\text{C}$
H11D3	I_{CER}			100	nA	$V_{CE} = 100\text{ V}; I_F = 0; T_A = 25^\circ\text{C}$
				250	μA	$V_{CE} = 100\text{ V}; I_F = 0; T_A = 100^\circ\text{C}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio, collector to emitter H11D1, H11D2, H11D3	CTR	20			%	$I_F = 10\text{ mA}; V_{CE} = 10\text{ V}$ $R_{BE} = 1\text{ meg}$
Saturation voltage	$V_{CE(SAT)}$		0.1	.40	V	$I_F = 10\text{ mA}; I_C = 0.5\text{ mA}$ $R_{BE} = 1\text{ meg}$

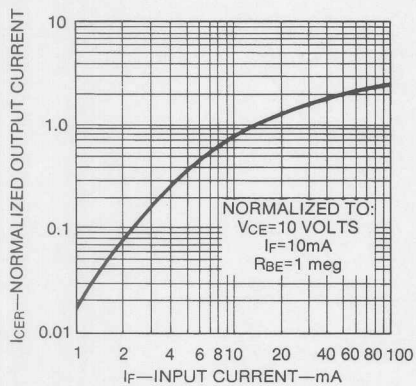
TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated Turn-on	t_{on}		5		μs	$V_{CE} = 10\text{ V}, I_{CE} = 2\text{ mA},$
Turn-off time	t_{off}		5		μs	$R_L = 100\text{ }\Omega$

ISOLATION CHARACTERISTICS

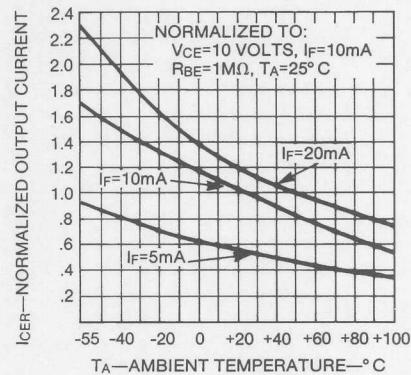
CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{ISO}	5300			$V_{AC\text{ RMS}}$	$I_{tO} \leq 1\text{ }\mu\text{A}, 1\text{ minute}$
	V_{ISO}	7500			$V_{AC\text{ PEAK}}$	$I_{tO} \leq 1\text{ }\mu\text{A}, 1\text{ minute}$
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{tO} = 500\text{ VDC}$
Isolation capacitance	C_{ISO}		0.5		pF	$f = 1\text{ MHz}$

TYPICAL CHARACTERISTICS



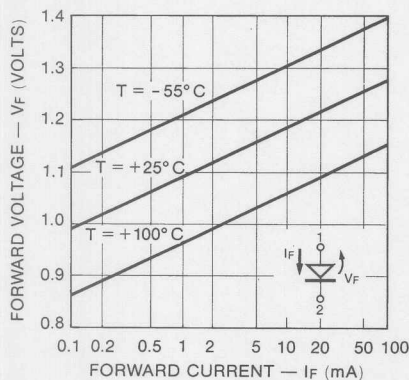
C1770

Fig. 1. Output Current vs. Input Current



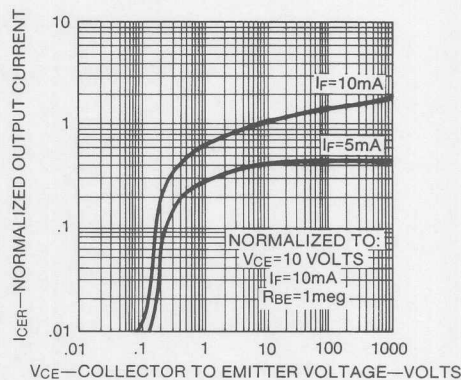
C1771

Fig. 2. Output Current vs. Temperature



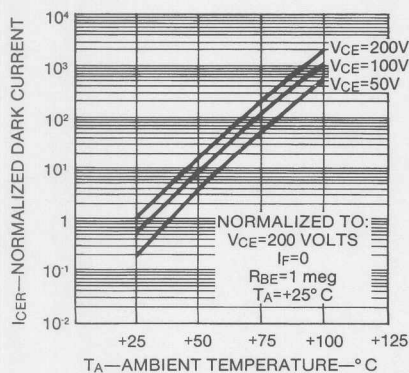
C1686

Fig. 3. Input Characteristics



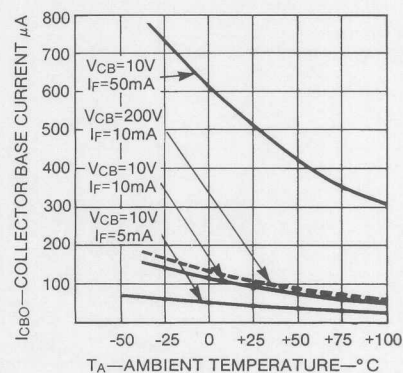
C1773

Fig. 4. Output Characteristics



C1774

Fig. 5. Normalized Dark Current vs. Temperature



C1775

Fig. 6. Collector Base Current vs. Temperature

TYPICAL CHARACTERISTICS

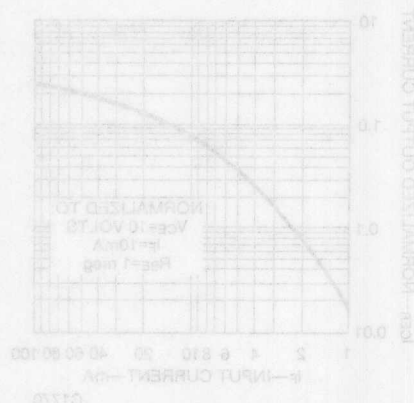


Fig. 1. Output Current vs. Input Current

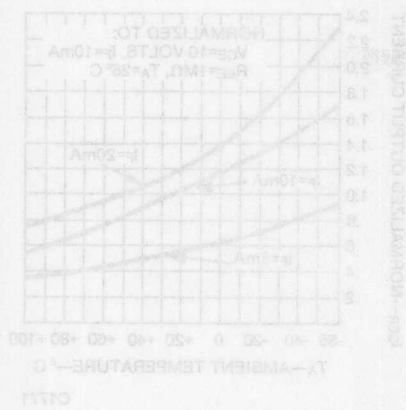


Fig. 2. Output Current vs. Temperature

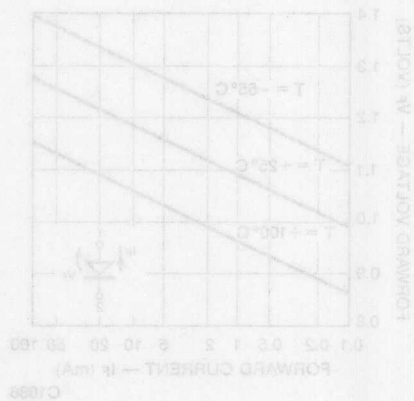


Fig. 3. Input Characteristics

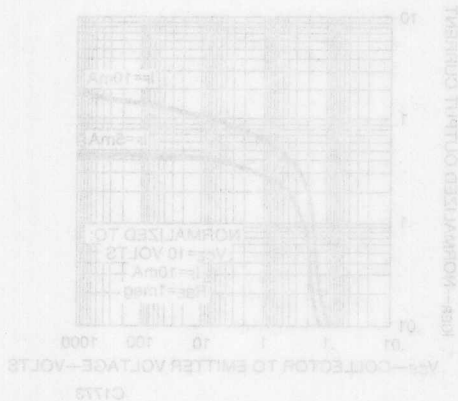


Fig. 4. Output Characteristics

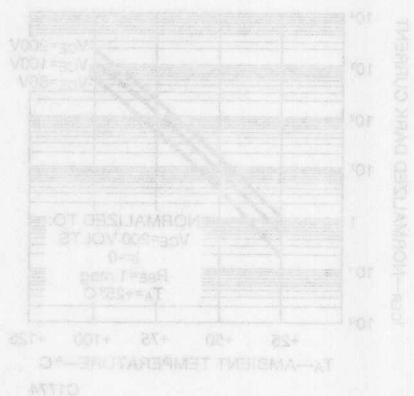


Fig. 5. Normalized Data Output vs. Temperature

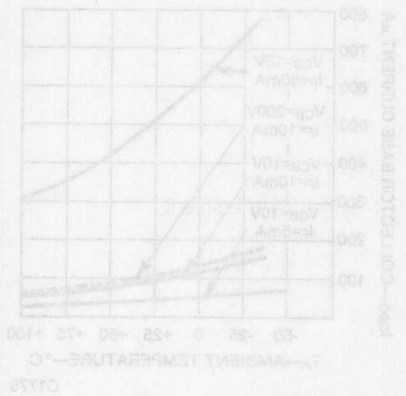
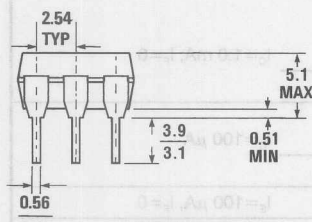
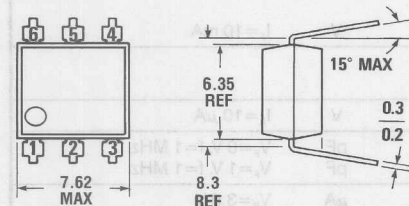


Fig. 6. Collector Base Current vs. Temperature

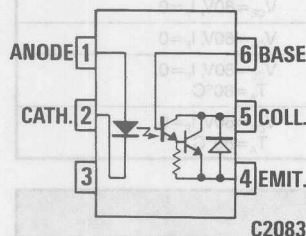
**H11G1
H11G2**

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE E

ST1603-02



Equivalent Circuit

DESCRIPTION

The H11G1 and H11G2 are the photodarlington-type optically coupled optoisolators. Both devices have a gallium arsenide infrared emitting diode coupled with a silicon darlington connected phototransistor which has an integral base-emitter resistor to optimize elevated temperature characteristics.

FEATURES

- High BV_{CEO}
Minimum 100V for H11G1
Minimum 80V for H11G2
- High sensitivity to low input current—Minimum 500 percent CTR at $I_F=1$ mA
- Low leakage current at elevated temperature (maximum 100 μ A at 80°C).
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- CMOS logic interface
- Telephone ring detector
- Low input TTL interface
- Power supply isolation
- Replace pulse transformer

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation at 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C
Isolation voltage	7500 VAC PEAK

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	6 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C
Collector to emitter voltage	
H11G1	100 V
H11G2	80 V

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS						
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F = 10 \text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$	-1.8			mV/°C	
Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10 \text{ } \mu\text{A}$
Junction capacitance	C_J		50		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
			65		pF	$V_F = 1 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R		0.35	10	μA	$V_R = 3.0 \text{ V}$
OUTPUT DARLINGTON						
Breakdown voltage						
Collector to emitter	BV_{CEO}				V	$I_C = 1.0 \text{ mA}; I_F = 0$
H11G1		100			V	
H11G2		80			V	
Collector to base	BV_{CBO}				V	$I_C = 100 \text{ } \mu\text{A}$
H11G1		100			V	
H11G2		80			V	
Emitter to base	BV_{EBO}	7	10		V	$I_E = 100 \text{ } \mu\text{A}, I_F = 0$
Leakage current						
Collector to emitter	I_{CEO}				nA	$V_{CE} = 80 \text{ V}, I_F = 0$
H11G1				100	nA	
H11G2				100	nA	$V_{CE} = 60 \text{ V}, I_F = 0$
H11G1				100	μA	$V_{CE} = 80 \text{ V}, I_F = 0, T_A = 80^\circ\text{C}$
H11G2				100	μA	$V_{CE} = 60 \text{ V}, I_F = 0, T_A = 80^\circ\text{C}$

TRANSFER CHARACTERISTICS						
DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio, collector to emitter	CTR				%	$I_F = 10 \text{ mA}; V_{CE} = 1 \text{ V}$
H11G1/2		1000			%	
H11G1/2		500			%	$I_F = 1 \text{ mA}; V_{CE} = 5 \text{ V}$
Saturation voltage	$V_{CE(SAT)}$		0.85	1.0	V	$I_F = 16 \text{ mA}; I_C = 50 \text{ mA}$
			0.75	1.0	V	$I_F = 1 \text{ mA}; I_C = 1 \text{ mA}$

TRANSFER CHARACTERISTICS						
CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Turn-on time	t_{on}		5		μs	$R_L = 100\Omega; I_F = 10 \text{ mA}$
Turn-off time	t_{off}		100		μs	$V_{CE} = 5 \text{ V}$ Pulse width $\leq 300 \text{ } \mu\text{sec}$, $f \leq 30 \text{ Hz}$

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Temperature Unless Otherwise Specified) (Cont'd)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{iso}	7500			VAC-PEAK	$I_{L0} \leq 1 \mu A$, 1 minute
		5300			VAC-rms	$I_{L0} \leq 1 \mu A$, 1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{L0} = 500$ VDC
Isolation capacitance	C_{iso}		0.5		pF	$f = 1$ MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

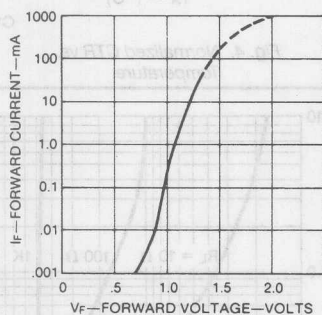


Fig. 1. Forward Voltage vs. Forward Current

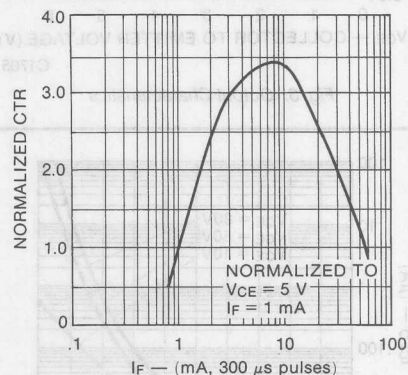
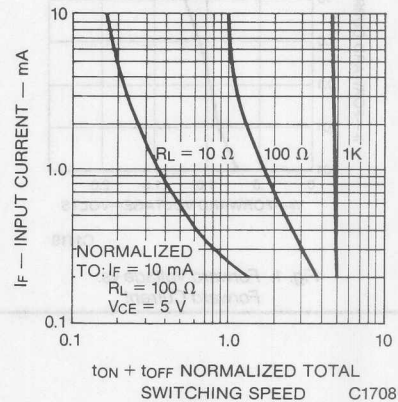
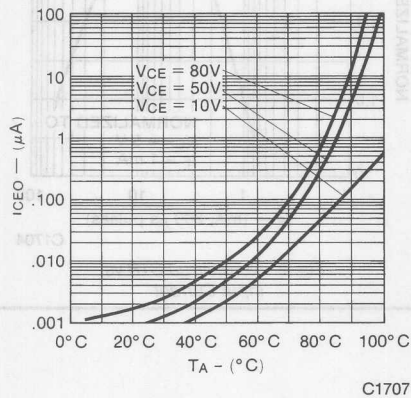
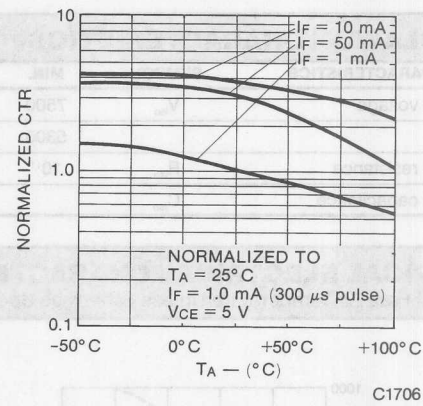
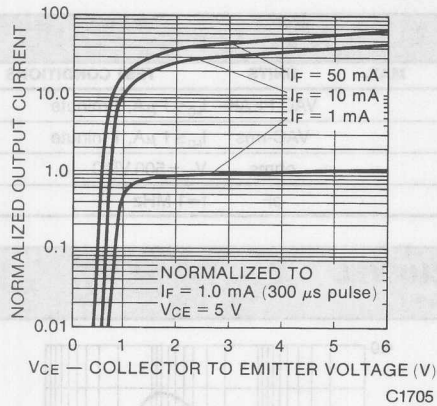


Fig. 2. Normalized CTR vs. Input Current

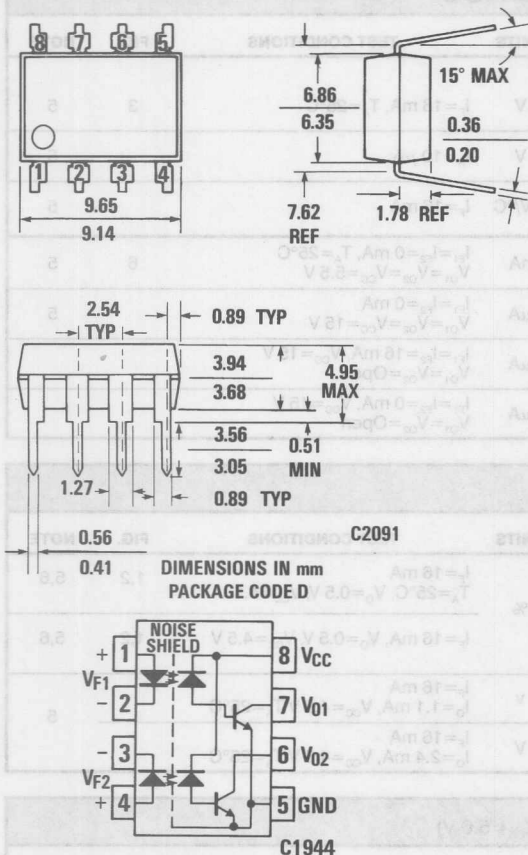
TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



HCPL-2530 HCPL-2531

PACKAGE DIMENSIONS



DESCRIPTION

The HCPL-2530/31 dual optocouplers contain two completely separated 700 nm GaAsP LED emitters each optically coupled to a high speed photodetector transistor.

A separate pin for the bias of the photodiodes improves the speed by several orders of magnitude by reducing the base-collector capacitance.

An internal noise shield provides superior common mode rejection of 10 kV/ μ s. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard of 220 V.

FEATURES

- High speed 1 MBit/s
- Superior CMR—10 kV/ μ s
- Double working voltage—480 V RMS
- CTR guaranteed 0-70°C
- U.L. recognized (File #E50151)

APPLICATIONS

- Line receivers
- Pulse transformer replacement
- Output interface to CMOS-LSTTL-TTL
- Wide bandwidth analog coupling

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	-55°C to 125°C
Operating temperature	-55°C to 100°C
Lead solder temperature	260°C for 10s

INPUT DIODE

Average forward input current (each channel)	25 mA (1)
Peak forward input current (each channel)	50 mA (2)
(50% duty cycle, 1 ms pulse width)	
Peak transient input current— I_F (each channel) ($\leq 1\mu$ s P.W., 300)	1.0 A
Reverse input voltage (each channel)	5 V
Input power dissipation (each channel)	45 mW (3)

OUTPUT TRANSISTOR

Average output current (each channel)	8 mA
Peak output current (each channel)	16 mA
Supply voltage - V_{CC} (Pin 8-5)	-0.5 V to 30 V
Output voltage - V_O (Pin 7, 6-5)	-0.5 V to 20 V
Output power dissipation (each channel)	35 mW (4)

ELECTRICAL CHARACTERISTICS ($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYM.	DEVICE HCPL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
DIODE									
Input forward Voltage	V_F			1.5	1.7	V	$I_F = 16\text{ mA}$, $T_A = 25^\circ\text{C}$	3	5
Input reverse breakdown volt.	B_{VR}		5			V	$I_R = 10\text{ }\mu\text{A}$		5
Temp. coefficient of forward volt.	$\frac{\Delta V_F}{\Delta T_A}$			-1.6		mV/ $^\circ\text{C}$	$I_F = 16\text{ mA}$		5
DETECTOR									
Logic high output current	I_{OH}			.02	500	nA	$I_{F1} = I_{F2} = 0\text{ mA}$, $T_A = 25^\circ\text{C}$ $V_{O1} = V_{O2} = V_{CC} = 5.5\text{ V}$	6	5
					10	μA	$I_{F1} = I_{F2} = 0\text{ mA}$ $V_{O1} = V_{O2} = V_{CC} = 15\text{ V}$		5
Logic low supply current	I_{CCL}			80		μA	$I_{F1} = I_{F2} = 16\text{ mA}$, $V_{CC} = 15\text{ V}$ $V_{O1} = V_{O2} = \text{Open}$		
Logic high supply current	I_{CCH}			.01	4	μA	$I_{F1} = I_{F2} = 0\text{ mA}$, $V_{CC} = 15\text{ V}$ $V_{O1} = V_{O2} = \text{Open}$		

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYM.	DEVICE HCPL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Current transfer ratio	CTR	2530	7	18			$I_F = 16\text{ mA}$ $T_A = 25^\circ\text{C}$, $V_O = 0.5\text{ V}$, $V_{CC} = 4.5\text{ V}$	1,2	5,6
		2531	19			%			
		2530	5	21			$I_F = 16\text{ mA}$, $V_O = 0.5\text{ V}$, $V_{CC} = 4.5\text{ V}$	1,2	5,6
		2531	15						
Logic low output voltage	V_{OL}	2530		.1	0.5	v	$I_F = 16\text{ mA}$ $I_O = 1.1\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $T_A = 25^\circ\text{C}$		5
		2531		.1	0.5	V	$I_F = 16\text{ mA}$ $I_O = 2.4\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $T_A = 25^\circ\text{C}$		

SWITCHING CHARACTERISTICS ($T_A = 25^\circ\text{C}$ $V_{CC} = 5.0\text{ V}$)

PARAMETER	SYM.	DEVICE HCPL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Propagation delay time (For output low level)	t_{PLH}	2530		0.5	1.5	μs	$I_F = 16\text{ mA}$, $R_L = 4.1\text{ k}\Omega$	5,11	10,11
		2531		0.3	0.8	μs	$I_F = 16\text{ mA}$, $R_L = 1.9\text{ k}\Omega$		
Propagation delay time (For output high level)	t_{PHL}	2530		0.2	1.5	μs	$I_F = 16\text{ mA}$, $R_L = 4.1\text{ k}\Omega$	5,11	10,11
		2531		0.1	0.8	μs	$I_F = 16\text{ mA}$, $R_L = 1.9\text{ k}\Omega$		
Common mode transient immunity at logic high level output	CM_H	2530	1000	10000		V/ μs	$R_L = 4.1\text{ k}\Omega$ $I_F = 0\text{ mA}$, $V_{CM} = 10\text{ V}_{PP}$	10	9,10,11
		2531	1000	10000		V/ μs	$R_L = 1.9\text{ k}\Omega$		
Common mode transient immunity at logic low level output	CM_L	2530	-1000	-10000		V/ μs	$R_L = 4.1\text{ k}\Omega$ $I_F = 16\text{ mA}$, $V_{CM} = 10\text{ V}_{PP}$	10	9,10,11
		2531	-1000	-10000		V/ μs	$R_L = 1.9\text{ k}\Omega$		
Bandwidth	BW			3		MHz	$R_L = 100\text{ }\Omega$	9	12

*All typicals at $T_A = 25^\circ\text{C}$

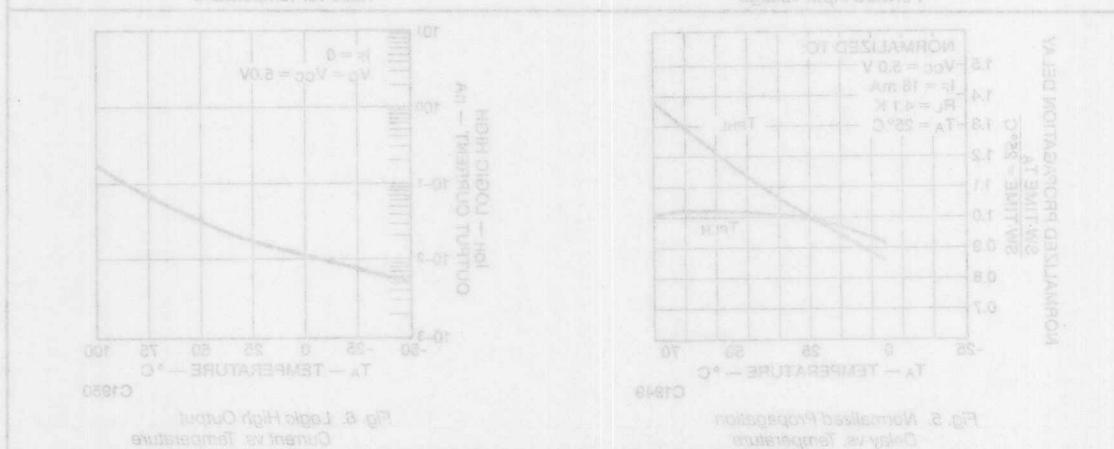
ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYM.	DEVICE HCPL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Input capacitance	C_{IN}			60		pF	$V_F=0$ V, $f=1$ MHz	5	
Withstand Insulation test voltage	V_{ISO}		2500			V_{RMS}	$RH \leq 50\%$ $T_A=25^\circ\text{C}$, $t=1$ min	7,13	
Resistance (input-output)	R_{IO}			10^{12}		Ω	$V_{IO}=500$ VDC	7	
Capacitance (input-output)	C_{IO}			0.6		pF	$f=1$ MHz	7	
Input-Input insulation leakage current	I_{II}			0.005		μA	$RH \leq 50\%$ $V_{II}=500$ VDC $t=5$ s	8	
Resistance (input-input)	R_{II}			10^{11}		Ω	$V_{II}=500$ VDC	8	
Capacitance (input-input)	C_{II}			0.25		pF	$f=1$ MHz	8	

*All typicals at $T_A=25^\circ\text{C}$

NOTES

- Derate linearly above 70°C free-air temperature at a rate of $0.8 \text{ mA}/^\circ\text{C}$.
- Derate linearly above 70°C free-air temperature at a rate of $1.6 \text{ mA}/^\circ\text{C}$.
- Derate linearly above 70°C free-air temperature at a rate of $0.9 \text{ mW}/^\circ\text{C}$.
- Derate linearly above 70°C free-air temperature at a rate of $1.0 \text{ mW}/^\circ\text{C}$.
- Each channel.
- CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I_O , to the forward LED input current, I_F , times 100%.
- Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
- Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
- Common mode transient immunity in Logic High level is the maximum tolerable (positive) dV_{CM}/dt on the leading edge of the common mode pulse V_{CM} , to assure that the output will remain in a Logic High State (i.e., $V_O \geq 2.0$ V). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) dV_{CM}/dt on the trailing edge of the common mode pulse signal, V_{CM} , to assure that the output will remain in a Logic Low state (i.e., $V_O \leq 0.8$ V).
- The $1.9 \text{ K}\Omega$ load represents 1 TTL unit load of 1.6 mA and the $5.6 \text{ K}\Omega$ pull-up resistor.
- The $4.1 \text{ K}\Omega$ load represents 1 LSTTL unit load of 0.36 mA and $6.1 \text{ K}\Omega$ pull-up resistor.
- The frequency at which the ac output voltage is 3dB below the low frequency asymptote.
- The $2500 \text{ V}_{RMS}/1 \text{ min}$ capability is validated by a factory $3.1 \text{ kV}_{RMS}/1 \text{ sec}$ dielectric voltage withstand test.



TYPICAL ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

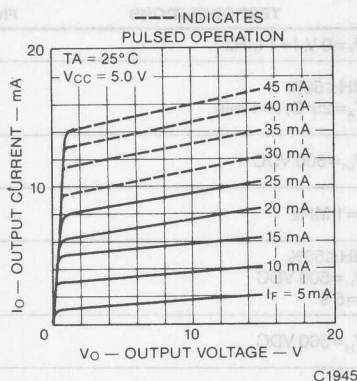


Fig. 1. DC and Pulsed Transfer Characteristics

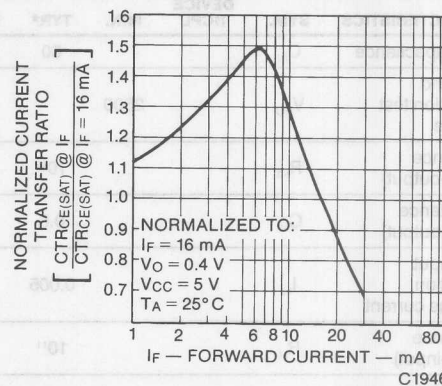


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

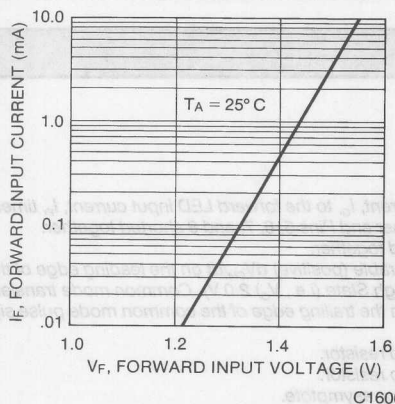


Fig. 3. Forward Input Current vs. Forward Input Voltage

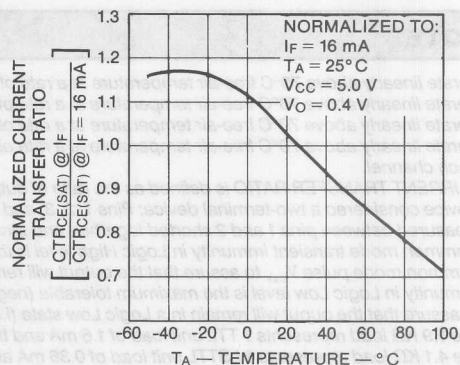


Fig. 4. Normalized Current Transfer Ratio vs. Temperature

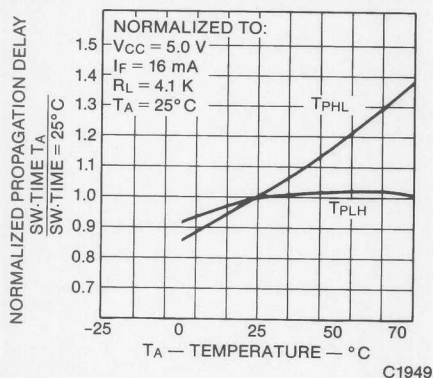


Fig. 5. Normalized Propagation Delay vs. Temperature

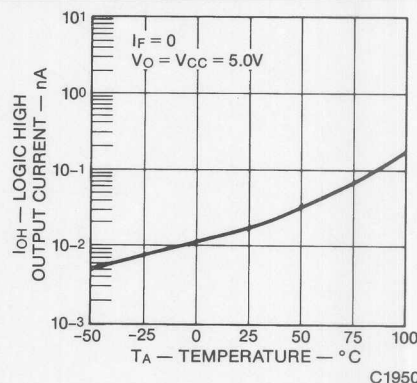


Fig. 6. Logic High Output Current vs. Temperature

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ$ Unless Otherwise Specified) (Cont'd)

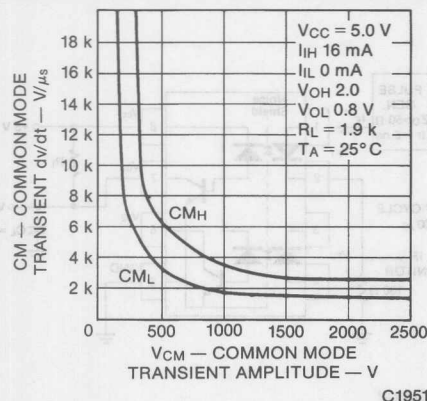


Fig. 7. Common Mode Transient Immunity vs. Common Mode Transient Amplitude

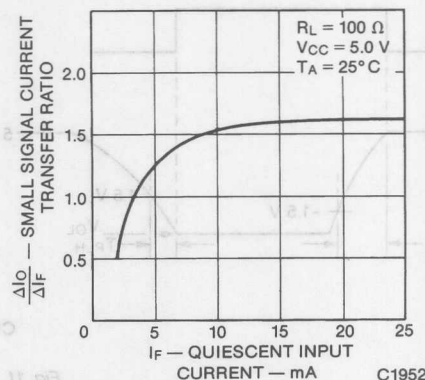


Fig. 8. Small Signal Transfer Ratio vs. Quiescent Input Current

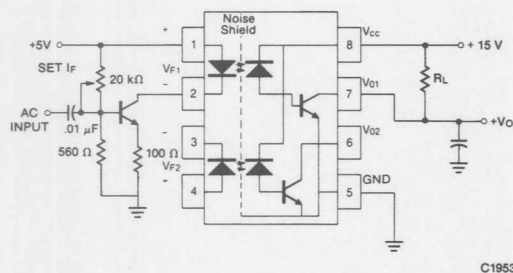


Fig. 9. Frequency Response

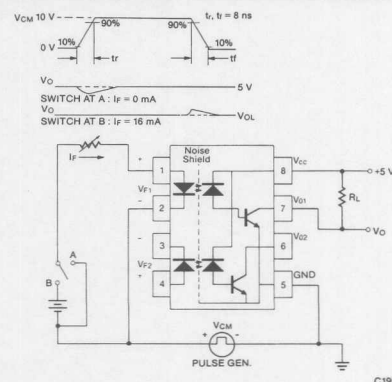
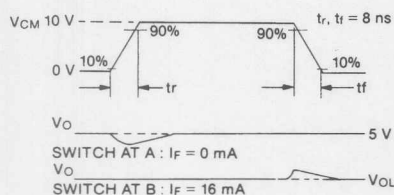
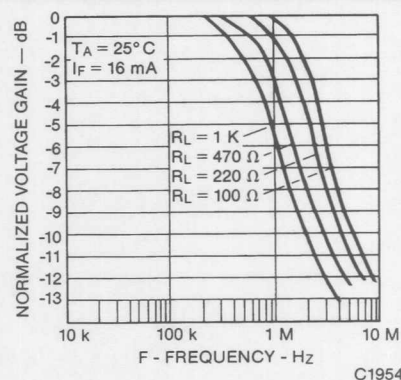
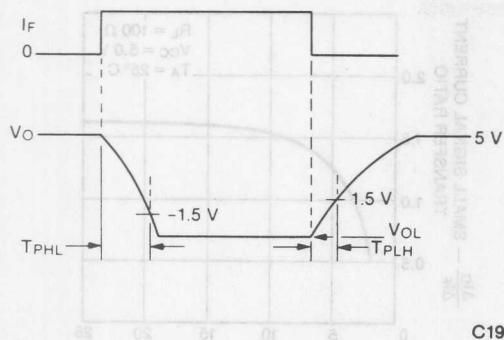


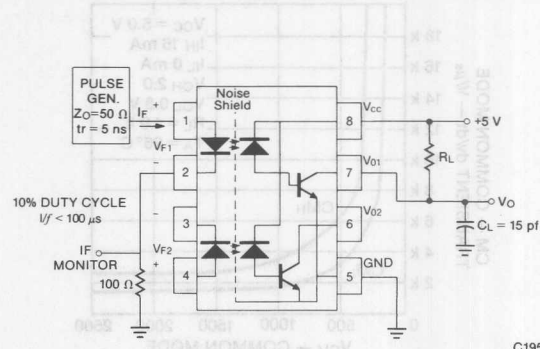
Fig. 10. Test Circuit for Transient Immunity and Typical Waveforms

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ$ Unless Otherwise Specified) (Cont'd)



C1956



C1956

Fig. 11. Switching Test Circuit

Fig. 8. Small Signal Transfer Ratio vs. Quiescent Input Current

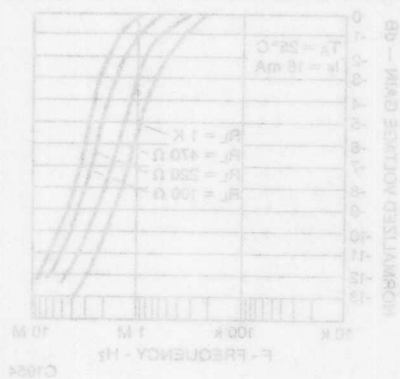


Fig. 9. Frequency Response

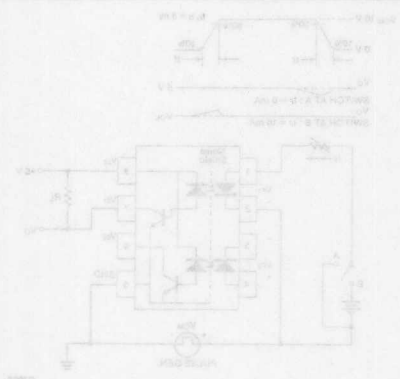


Fig. 10. Test Circuit for Transient Immunity and Typical Waveforms

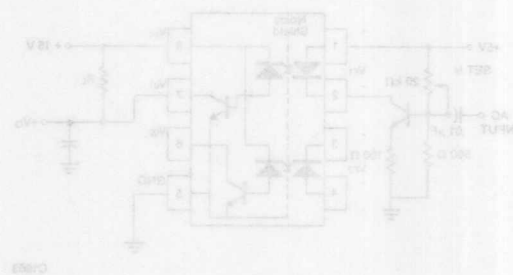
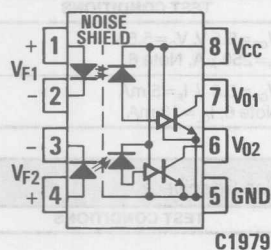
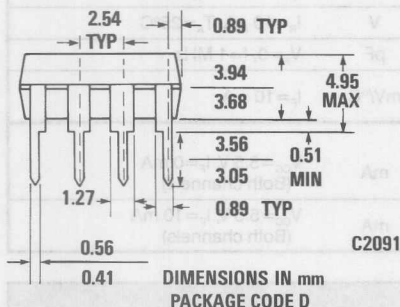
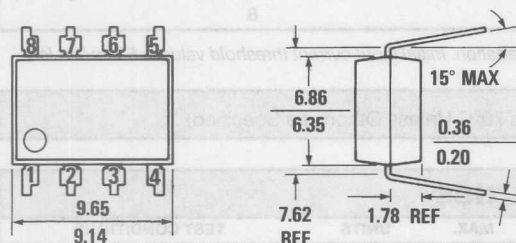


Fig. 7. Common Mode Transient Immunity vs. Transient Amplitude

**HCPL-2630
DUAL 10 MBit/s LOGIC GATE HCPL-2631**

PACKAGE DIMENSIONS



Equivalent Circuit

A 0.1 μ F bypass capacitor must be connected between pins 8 and 5. (See note 1)

DESCRIPTION

The HCPL-2630 and HCPL-2631 dual channel optocouplers have two channels, each consisting of a 700 nm GaAsP LED, optically coupled to a very high speed integrated photodetector logic gate. The outputs feature open collectors, thereby permitting wired-OR outputs. The coupled parameters are guaranteed over the temperature range of 0-70°C. A maximum input signal of 5 mA will provide a minimum output sink current of 13 mA (fan-out of 8).

An internal noise shield provides superior common mode rejection of typically 10 kV/ μ s. The HCPL-2631 has a minimum CMR of 1 kV/ μ s.

An improved double-molded package allows superior insulation, permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Very high speed—10 MBit/s
- Superior CMR—10 kV/ μ s
- Double working voltage—480 V
- Fan-out of 8 over 0-70°C
- Logic gate output
- Wired-OR—open collector
- U.L. recognized (File #E50151)

APPLICATIONS

- Ground loop elimination
- LSTTL to TTL, LSTTL or 5-volt CMOS
- Line receiver, data transmission
- Data multiplexing
- Switching power supplies
- Pulse transformer replacement
- Computer-peripheral interface

ABSOLUTE MAXIMUM RATINGS

Storage temperature	-55°C to +125°C
Operating temperature	0°C to +70°C
Lead solder temperature	260°C for 10s

INPUT DIODE

DC/average forward input current (each channel)	15 mA
Peak forward input current (each channel)	30 mA (≤ 1 msec duration)
Reverse input voltage (each channel)	5.0 V
Reverse supply voltage ($-V_{CC}$)	-500 mV

OUTPUT TRANSISTOR

Supply voltage, (V_{CC})	7.0 V/1 minute maximum
Output current, (I_O) (each channel)	16 mA
Output voltage, (V_O) (each channel)	7.0 V
Collector output power dissipation	60 mW

RECOMMENDED OPERATING CONDITIONS

	SYMBOL	MIN.	MAX.	UNITS
Input current, low level	I_{FL}	0	250	μA
Input current, high level	I_{FH}	6.3*	15	mA
Supply voltage, output	V_{CC}	4.5	5.5	V
Operating temperature	T_A	0	70	$^{\circ}C$
Fan out (TTL load)	N		8	

*6.3 mA is a guard banded value which allows for at least 20% CTR degradation. Initial input current threshold value is 5.0 mA or less.

ELECTRICAL CHARACTERISTICS ($T_A=0^{\circ}C$ to $70^{\circ}C$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DIODE						
Input forward voltage	V_F		1.55	1.75	V	$I_F=10$ mA, $T_A=25^{\circ}C$
Input reverse breakdown voltage	B_{VR}	5.0			V	$I_R=10$ μA , $T_A=25^{\circ}C$
Input capacitance	C_{IN}		60		pF	$V_F=0$, $f=1$ MHz
Input diode temperature coefficient	$\Delta V_F/\Delta T_A$		-1.4		mV/ $^{\circ}C$	$I_F=10$ mA
DETECTOR						
High level supply current	I_{CH}		14	30	mA	$V_{CC}=5.5$ V, $I_F=0$ mA (Both channels)
Low level supply current	I_{CCL}		26	36	mA	$V_{CC}=5.5$ V, $I_F=10$ mA (Both channels)

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
High level output current	I_{OH}		2	250	μA	$V_{CC}=5.5$ V, $V_O=5.5$ V $I_F=250$ μA , Note 6
Low level output voltage	V_{OL}		0.34	0.6	V	$V_{CC}=5.5$ V, $I_F=5$ mA Note 6, $I_{OL}=13$ mA

SWITCHING CHARACTERISTICS ($T_A=25^{\circ}C$, $V_{CC}=5.0$ V Unless Otherwise Specified)

AC CHARACTERISTICS	SYMBOL	DEVICE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Propagation delay time (for output high level)	t_{PLH}			48	75	ns	
Propagation delay time (for output low level)	t_{PHL}			48	75	ns	$R_L=350$ Ω $C_L=15$ pF
Output rise time (10-90%)	t_r			30		ns	$I_F=7.5$ mA
Output fall time (90-10%)	t_f			14		ns	Notes 2, 3, 4 & 5, Fig. 7
Common mode transient immunity (At output high level)	CM_H	2631 2630	1000	10,000 10,000		V/ μs	$V_{CM}=50$ V (peak) $I_F=0$ mA, $V_{OL}(\min)=2.0$ V $R_L=350$ Ω , Note 9, Fig. 11
Common mode transient immunity (at output low level)	CM_L	2631 2630	-1000	-10,000 -10,000		V/ μs	$V_{CM}=50$ V (peak) $I_F=7.5$ mA, $V_{OL}(\max)=0.8$ V $R_L=350$ Ω , Note 8, Fig. 11

*All typical values are at $V_{CC}=5$ V, $T_A=25^{\circ}C$ (each channel).

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input-input insulation leakage current	I_{I-I}		0.005		μA	Relative humidity=45% $t=5$ s, $V_{I-I}=500$ V, Note 7
Resistance (input-input)	R_{I-I}		10^{11}		Ω	$V_{I-I}=500$ V, Note 7
Capacitance (input-input)	C_{I-I}		0.25		pF	$f=1$ MHz, Note 7
Input-output insulation leakage current	I_{I-O}			1.0	μA	Relative humidity=45% $T_A=25^\circ C$, $t=5$ s $V_{I-O}=3000$ V dc Note 10
Resistance (input to output)	R_{I-O}		10^{12}		Ω	$V_{I-O}=500$ V, Note 10
Capacitance (input to output)	C_{I-O}		0.6		pF	$f=1$ MHz, Note 10
Withstand insulation test voltage	V_{ISO}	2500			V_{RMS}	RH<50% $T_A=25^\circ C$ $t=1$ min

*All typical values are at $V_{CC}=5$ V, $T_A=25^\circ C$ (each channel).

TYPICAL CHARACTERISTIC CURVES ($T_A=25^\circ C$ Unless Otherwise Specified)

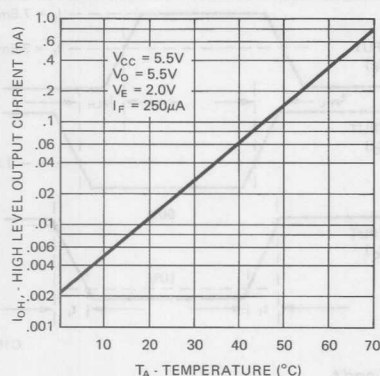


Fig. 1. High Level Output Current vs. Temperature

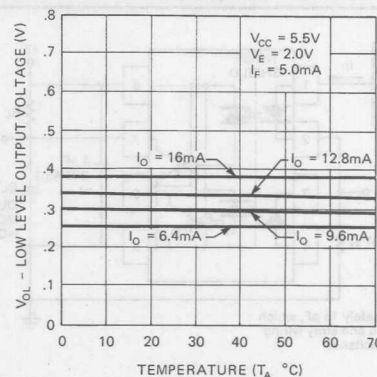


Fig. 2. Low Level Output Voltage vs. Temperature

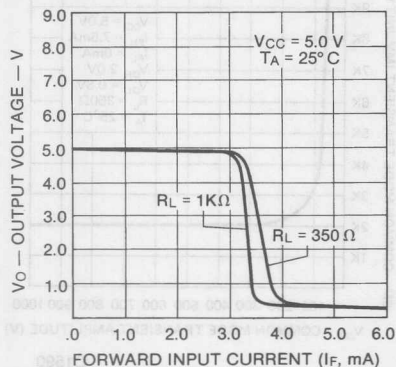


Fig. 3. Output Voltage vs. Forward Input Current

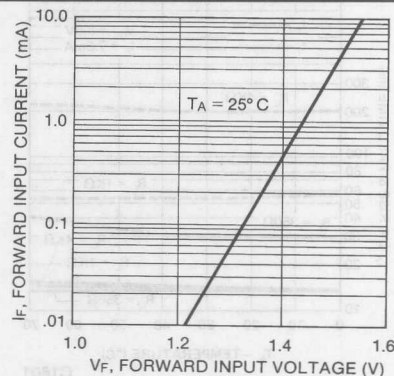
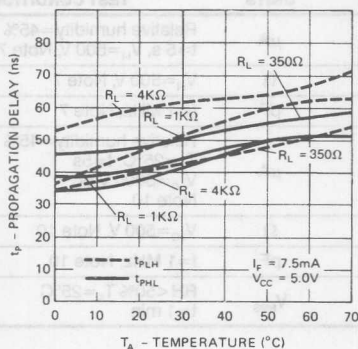


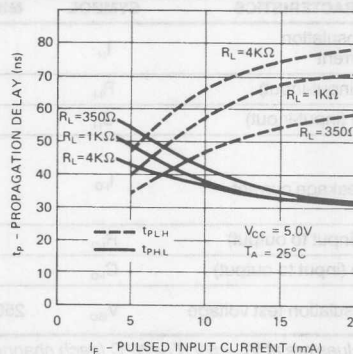
Fig. 4. Forward Input Current vs. Forward Input Voltage

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)



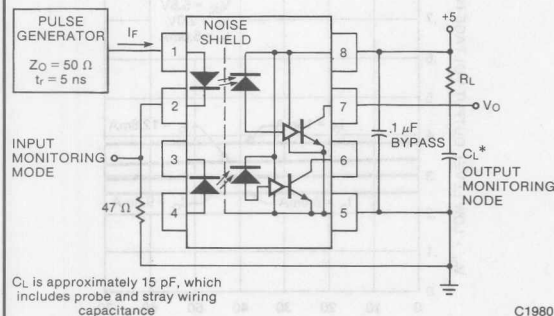
C1604

Fig. 5. Propagation Delay vs. Temperature



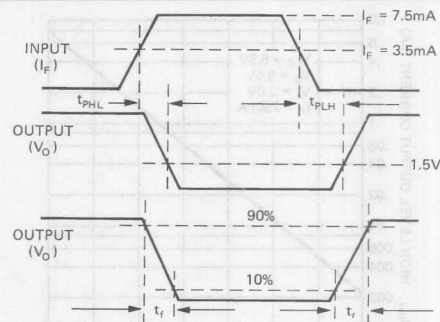
C1603

Fig. 6. Propagation Delay vs. Pulse Input Current

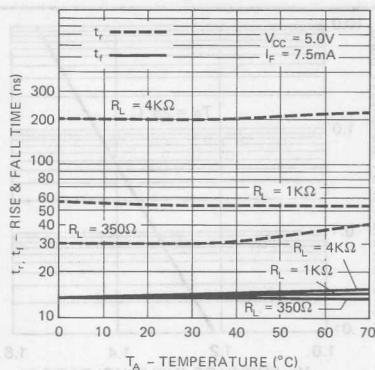


C1980

Fig. 7. Test Circuit t_{PHL} , t_{PLH} , t_r and t_f

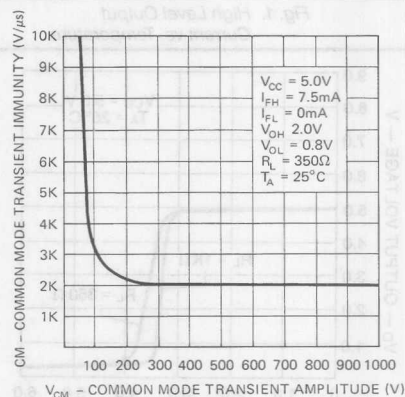


C1597



C1601

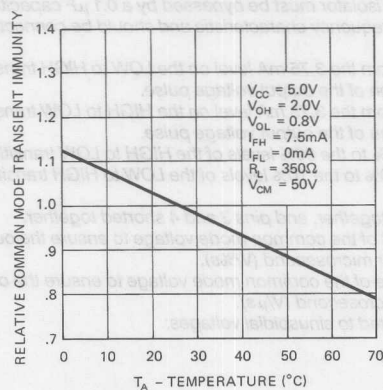
Fig. 8. Rise and Fall Time vs. Temperature



C1590

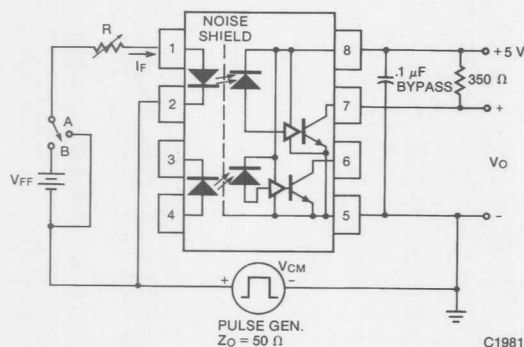
Fig. 9. Relative Common Mode Transient Immunity vs. Common Mode Transient Amplitude

TYPICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

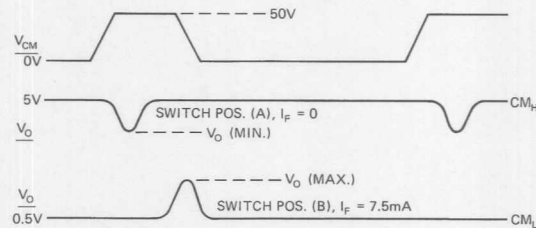


C1595

Fig. 10. Relative Common Mode Transient Immunity vs. Temperature



C1981



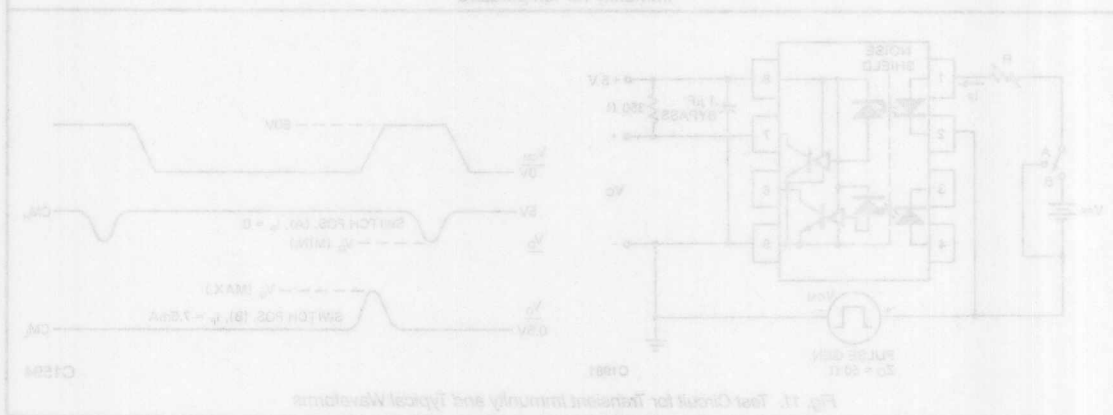
C1594

Fig. 11. Test Circuit for Transient Immunity and Typical Waveforms

NOTES

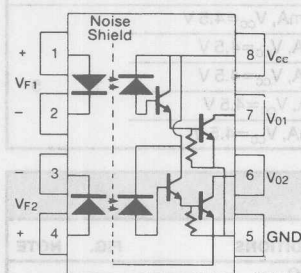
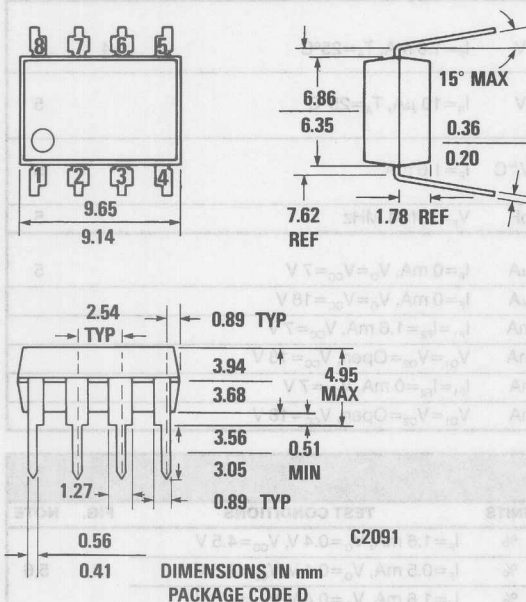
1. The V_{CC} supply voltage to each MCL2630 isolator must be bypassed by a $0.1 \mu F$ capacitor or larger. This can be either a ceramic or solid tantalum capacitor with good high frequency characteristic and should be connected as close as possible to the package V_{CC} and GND pins of each device.
2. t_{PHL} - Propagation delay is measured from the 3.75 mA level on the LOW to HIGH transition of the input current pulse to the 1.5 V level on the HIGH to LOW transition of the output voltage pulse.
3. t_{PLH} - Propagation delay is measured from the 3.75 mA level on the HIGH to LOW transition of the input current pulse to the 1.5 V level on the LOW to HIGH transition of the output voltage pulse.
4. t_f - Fall time is measured from the 10% to the 90% levels of the HIGH to LOW transition on the output pulse.
5. t_r - Rise time is measured from the 90% to the 10% levels of the LOW to HIGH transition on the output pulse.
6. Each channel.
7. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
8. CM_L - The maximum tolerable rate of fall of the common mode voltage to ensure the output will remain in the low output state (i.e., $V_{OUT} > 0.8 V$). Measured in volts per microsecond (V/ μs).
9. CM_H - The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e., $V_{OUT} > 2.0 V$). Measured in volts microsecond (V/ μs).
Volts/microsecond can be translated to sinusoidal voltages:
$$V/\mu s = \frac{(dV_{CM})}{dt} \text{ Max.} = \pi f_{CM} V_{CM}(p.p.)$$

Example: $V_{CM} = 318 V_{pp}$ when $f_{CM} = 1 \text{ MHz}$ using CM_L and $CM_H = 1000 V/\mu s$.
10. - Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.



**1.6 mA DUAL HCPL-2730
0.5 mA DUAL HCPL-2731**

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The HCPL-2730/31 dual channel optocouplers contain two completely separated 700nm GaAsP LED emitters. Each channel is optically coupled to high gain detector in a split Darlington Configuration, which provides extremely high current transfer ratio.

The split darlington configuration separating the input photodiode and the first stage gain from the output transistor permits lower output saturation voltage and higher speed operation than possible with conventional darlington phototransistor optocoupler. An integrated emitter-base resistor provides superior stability over temperature.

The combination of a very low input current of 0.5 mA and a high current transfer ratio of 2000% make this family particularly useful for input interface to MOS, CMOS, LSTTL and EIA RS232C, while output compatibility is ensured to CMOS as well as high fan-out requirements.

An internal noise shield provides exceptional common mode rejection of 10 kV/μs. An improved package allows superior insulation permitting a 480 V working voltage compared to industry standard 220 V.

FEATURES

- Low current—0.5 mA
- Superior CTR—2000%
- Superior CMR—10 kV/μs
- Double working voltage—480 V RMS
- CTR guaranteed 0-70°C

APPLICATIONS

- Digital logic ground isolation
- Telephone ring detector
- High common-mode-noise line receiver

ABSOLUTE MAXIMUM RATINGS

Storage temperature	−55°C to +125°C
Operating temperature	−40°C to +85°C
Lead solder temperature	260°C for 10 s

INPUT DIODE

DC/average forward input current (each channel)	20 mA (1)
Peak forward input current (each channel)	40 mA
(≤1 msec duration, 50% duty cycle) (1)	
Reverse input voltage (each channel)	5.0 V
Input power dissipation (each channel)	35 mW (2)

OUTPUT TRANSISTOR

Output current (each channel)	60 mA (3)
Supply and output voltage (V _{CC} , V _O)	
MCL2730 (HCPL-2730)	−0.5 to 7 V
MCL2731 (HCPL-2731)	−0.5 to 18 V
Output power dissipation (each channel)	100 mW (4)

ELECTRICAL CHARACTERISTICS ($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYM.	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
DIODE									
Input forward voltage	V_F			1.5	1.7	V	$I_F = 1.6 \text{ mA}$, $T_A = 25^\circ\text{C}$	4	5
Input reverse breakdown voltage	B_{VR}		5			V	$I_R = 10 \mu\text{A}$, $T_A = 25^\circ\text{C}$		5
Temperature coefficient of forward voltage	$\frac{\Delta V_F}{\Delta T_A}$			-1.6		mV/ $^\circ\text{C}$	$I_F = 1.6 \text{ mA}$		5
Input capacitance	C_{IN}			60		pF	$V_F = 0$, $f = 1 \text{ MHz}$		5
DETECTOR									
Logic high output current	I_{OH}	2730		0.01	100	μA	$I_F = 0 \text{ mA}$, $V_O = V_{CC} = 7 \text{ V}$		5
		2731		0.01	100	μA	$I_F = 0 \text{ mA}$, $V_O = V_{CC} = 18 \text{ V}$		
Logic low supply current	I_{CCL}	2730		.4		mA	$I_{F1} = I_{F2} = 1.6 \text{ mA}$, $V_{CC} = 7 \text{ V}$		
		2731		.5		mA	$V_{O1} = V_{O2} = \text{Open}$, $V_{CC} = 18 \text{ V}$		
Logic high supply current	I_{CCH}	2730		4		nA	$I_{F1} = I_{F2} = 0 \text{ mA}$, $V_{CC} = 7 \text{ V}$		
		2731		5		nA	$V_{O1} = V_{O2} = \text{Open}$, $V_{CC} = 18 \text{ V}$		

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYM.	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Current transfer ratio	CTR	2730	300	2000		%	$I_F = 1.6 \text{ mA}$, $V_O = 0.4 \text{ V}$, $V_{CC} = 4.5 \text{ V}$		
		2731	400	2000		%	$I_F = 0.5 \text{ mA}$, $V_O = 0.4 \text{ V}$, $V_{CC} = 4.5 \text{ V}$	2	5,6
			500	2000		%	$I_F = 1.6 \text{ mA}$, $V_O = 0.4 \text{ V}$, $V_{CC} = 4.5 \text{ V}$		
Logic low output voltage	V_{OL}	2730		.1	0.4	V	$I_F = 1.6 \text{ mA}$, $I_O = 4.8 \text{ mA}$, $V_{CC} = 4.5 \text{ V}$		
				.1	0.4	V	$I_F = 0.5 \text{ mA}$, $I_O = 2 \text{ mA}$, $V_{CC} = 4.5 \text{ V}$		
		2731		.1	0.4	V	$I_F = 1.6 \text{ mA}$, $I_O = 8 \text{ mA}$, $V_{CC} = 4.5 \text{ V}$	1	5
				.1	0.4	V	$I_F = 5 \text{ mA}$, $I_O = 15 \text{ mA}$, $V_{CC} = 4.5 \text{ V}$		
				.2	0.4	V	$I_F = 12 \text{ mA}$, $I_O = 24 \text{ mA}$, $V_{CC} = 4.5 \text{ V}$		

SWITCHING CHARACTERISTICS ($T_A = 25^\circ\text{C}$, $V_{CC} = 5.0 \text{ V}$)

AC CHARACTERISTICS	SYM.	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Propagation delay time (For output low level)	t_{PHL}	2730/1		4	20	μs	$I_F = 1.6 \text{ mA}$, $R_L = 2.2 \text{ k}\Omega$		
				0.5	2	μs	$I_F = 12 \text{ mA}$, $R_L = 270 \Omega$	6	5
		2731		25	100	μs	$I_F = 0.5 \text{ mA}$, $R_L = 4.7 \text{ k}\Omega$		
Propagation delay time (For output high level)	t_{PLH}	2730/1		12	35	μs	$I_F = 1.6 \text{ mA}$, $R_L = 2.2 \text{ k}\Omega$		
				4	10	μs	$I_F = 12 \text{ mA}$, $R_L = 270 \Omega$	6	5
		2731		20	60	μs	$I_F = 0.5 \text{ mA}$, $R_L = 4.7 \text{ k}\Omega$		
Common mode transient immunity at logic high level output	CM_H		1000	10000		V/ μs	$I_F = 0 \text{ mA}$, $R_L = 2.2 \text{ k}\Omega$ $V_{CM} = 10 V_{PP}$	7	5,9
Common mode transient immunity at logic low level output	CM_L		-1000	-10000		V/ μs	$I_F = 16 \text{ mA}$, $R_L = 2.2 \text{ k}\Omega$ $V_{CM} = 10 V_{PP}$	7	5,8

*All typicals at $T_A = 25^\circ\text{C}$

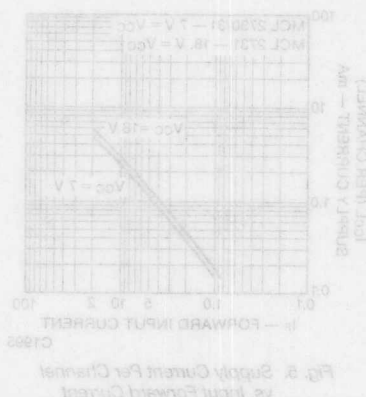
ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYM.	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Withstand insulation test voltage	V_{ISO}		2500			V_{RMS}	$RH \leq 50\%$, $T_A = 25^\circ C$ $t = 1 \text{ min}$	10,11	
Resistance (input-output)	R_{i-o}			10^{12}		Ω	$V_{i-o} = 500 \text{ VDC}$	10	
Capacitance (input-output)	C_{i-o}			0.6		pF	$f = 1 \text{ MHz}$	10	
Insulation leakage current (input-input)	I_{IH}			0.005		μA	$RH \leq 50\%$, $V_H = 500 \text{ VDC } t = 5 \text{ sec}$	7	
Resistance (input-input)	R_{IH}			10^{11}		Ω	$V_H = 500 \text{ VDC}$	7	
Capacitance (input-input)	C_H			0.25		pF	$f = 1 \text{ MHz}$	7	

*All typicals at $T_A = 25^\circ C$

NOTES

- Derate linearly above $70^\circ C$ free-air temperature at a rate of $0.5 \text{ mA}/^\circ C$.
- Derate linearly above $70^\circ C$ free-air temperature at a rate of $0.9 \text{ mW}/^\circ C$.
- Derate linearly above $70^\circ C$ free-air temperature at a rate of $0.6 \text{ mA}/^\circ C$.
- Derate linearly above $35^\circ C$ free-air temperature at a rate of $1.7 \text{ mW}/^\circ C$.
Output power = (Collector output) + (supply power).
- Each channel.
- CURRENT TRANSFER RATIO is defined as the ratio of the output collector current, I_O , to the forward LED input current I_F , times 100%.
- Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
- CM_L - The maximum tolerable rate of the common mode voltage to ensure the output will remain in the low output state (i.e., $V_{OUT} > 0.8 \text{ V}$). Measured in volts per microsecond ($V/\mu S$).
- CM_H - The maximum tolerable rate of rise of the common mode voltage to ensure the output will remain in the high state (i.e., $V_{OUT} > 2.0 \text{ V}$). Measured in volts per microsecond ($V/\mu S$).
$$V/\mu S = \frac{dV_{CM}}{dt} \text{ Max} = \pi f_{CM} V_{CM}(p.p.)$$
- Device considered a two-terminal device: Pins 1, 2, 3 and 4 shorted together, and Pins 5, 6, 7 and 8 shorted together.
- The $2.5 \text{ kV RMS/1 minute}$ capability is validated by a factory 3.1 kV RMS/1 sec .



TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

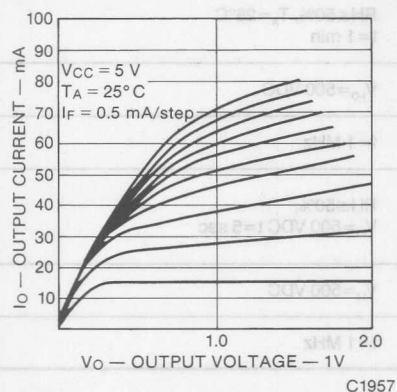


Fig. 1. DC Transfer Characteristics

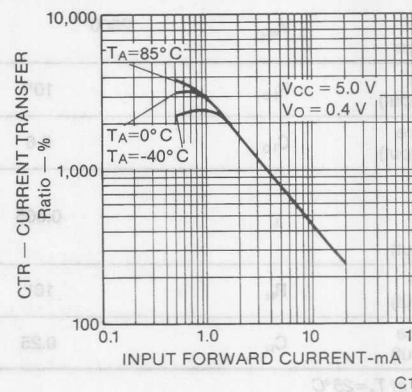


Fig. 2. Current Transfer Ratio vs. Input Forward Current

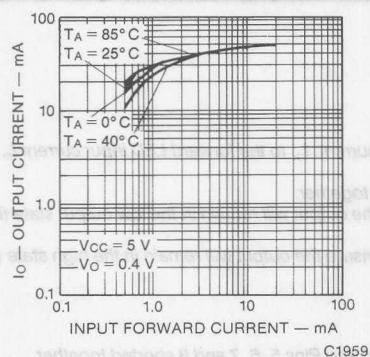


Fig. 3. Output Current vs. Input Forward Current

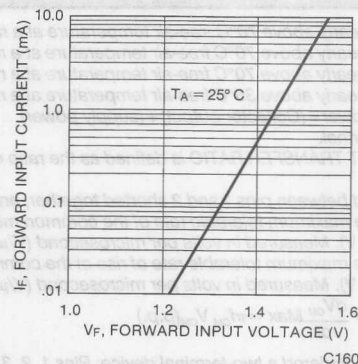


Fig. 4. Forward Input Current vs. Forward Input Voltage

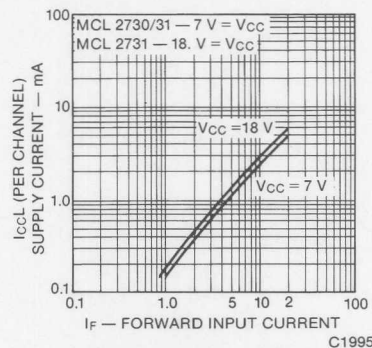


Fig. 5. Supply Current Per Channel vs. Input Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified) (Cont'd)

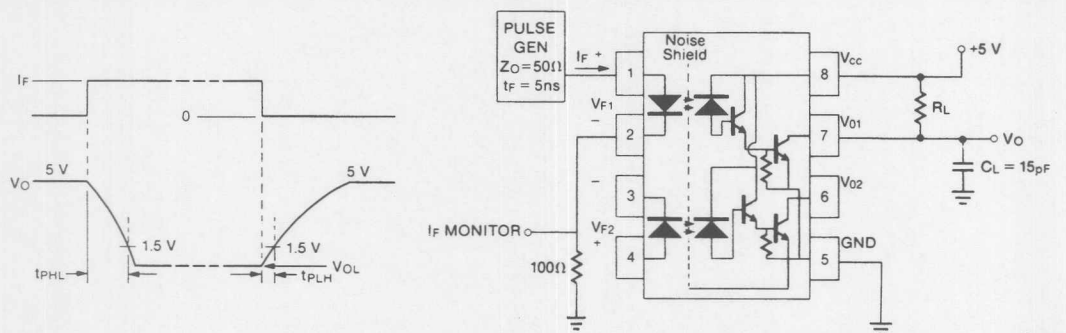


Fig. 6. Switching Test Circuit and Waveforms

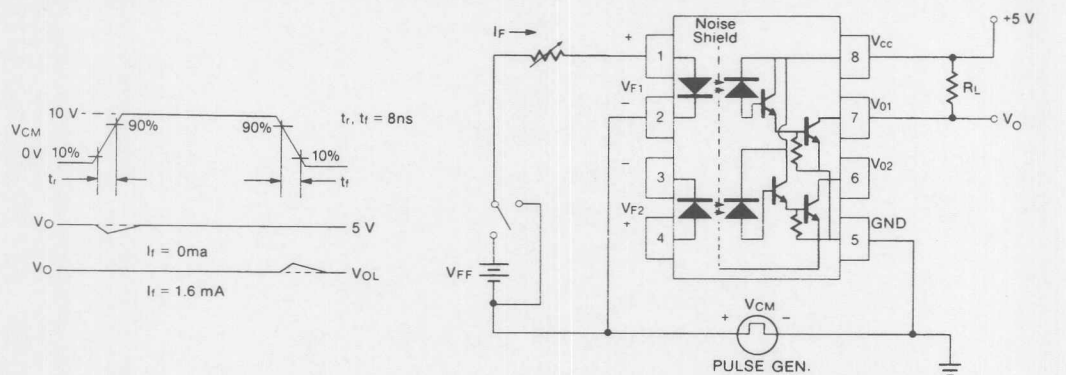
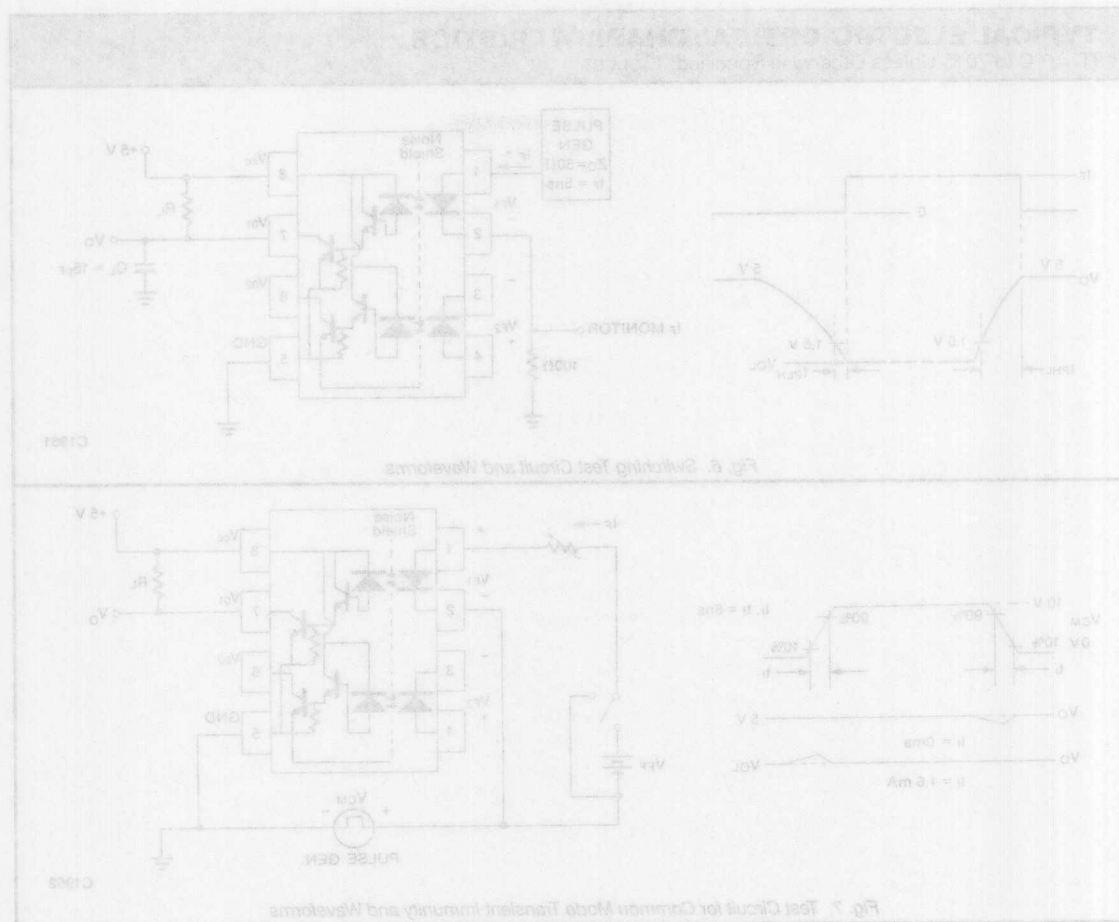
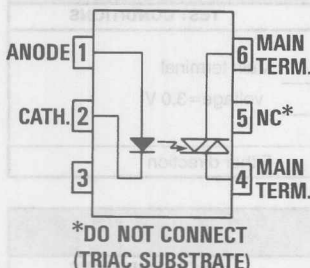
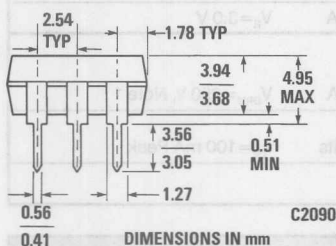
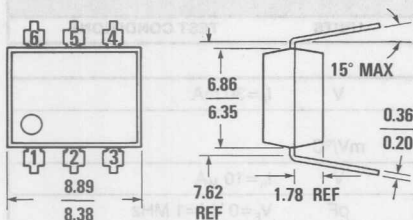


Fig. 7. Test Circuit for Common Mode Transient Immunity and Waveforms



MCP3009 MCP3010 MCP3011

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The MCP3009, MCP3010 and MCP3011 are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. This series is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 120 VAC operations.

FEATURES

- Low input current required (typically 5mA—MCP3011)
- Minimum commutating dv/dt is specified at 0.1V/μsec
- Pin for pin replacement for the MOC3009, 3010 and 3011 devices
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized—File E50151

APPLICATIONS

- Triac driver
- Industrial controls
- Traffic lights
- Vending machines
- Motor control
- Solid state relay

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−40°C to 100°C
Lead temperature (soldering 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	330 mW
Derate linearly from 25°C	4.0 mW/°C
Withstand test voltage	7500 VAC Peak (50-60 Hz)

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.33 mW/°C

OUTPUT DRIVER

Off-state output terminal voltage	250 volts
On-state RMS current (Full cycle, 50 to 60 Hz)	T _A =25°C 100 mA T _A =70°C 50 mA
Peak nonrepetitive surge current (PW=10 ms, DC=10%)	1.2 A
Total power dissipation @ T _A =25°C	300 mW
Derate above 25°C	4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F = 30 \text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10 \text{ } \mu\text{A}$
Junction capacitance	C_j		50		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
			65		pF	$V_F = 1 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R		.35	10	μA	$V_R = 3.0 \text{ V}$
OUTPUT DETECTOR						
Peak blocking current, either direction	I_{DRM}	—	10	100	nA	$V_{DRM} = 250 \text{ V}$, Note 1
Peak on-state voltage, either direction	V_{TM}	—	2.0	3.0	Volts	$I_{TM} = 100 \text{ mA Peak}$

Note 1. Test voltage must be applied within dv/dt rating.

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
LED trigger current (current required to latch output)	I_{FT}	—	15.0	30	mA	Main terminal voltage = 3.0 V
	I_{FT}	—	10.0	15	mA	
	I_{FT}	—	5	10	mA	
Holding current	I_H	—	200	—	μA	Either direction

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
AC dv/dt RATING						
Critical rate of rise of off-state voltage	dv/dt	—	10.0	—	V/ μs	Static dv/dt (see Fig. 4)
Critical rate of rise of commutating voltage	dv/dt	0.1	0.2	—	V/ μs	Commutating dv/dt $I_{LOAD} = 15 \text{ mA}$ (see Fig. 4)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{iso}	5300			$V_{AC RMS}$	$I_{LO} \leq 1 \text{ } \mu\text{A}$, 1 minute
	V_{iso}	7500			$V_{AC PEAK}$	$I_{LO} \leq 1 \text{ } \mu\text{A}$, 1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{LO} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f = 1 \text{ MHz}$

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

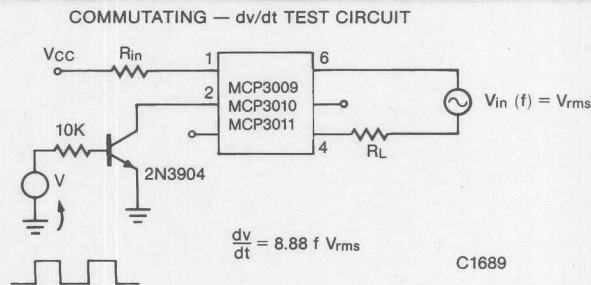
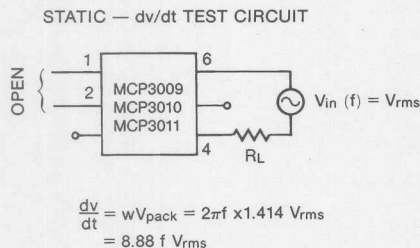
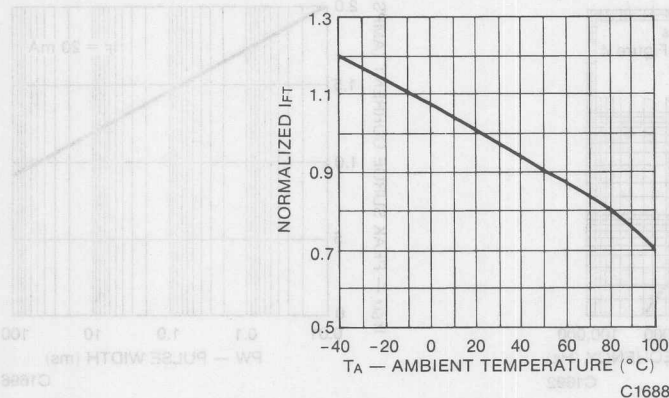
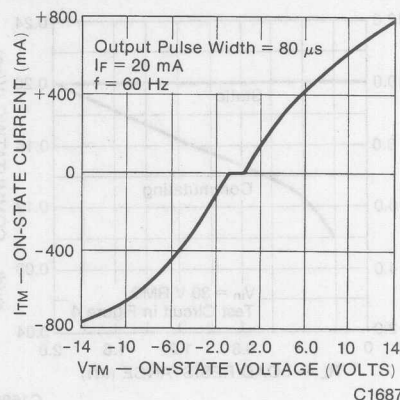
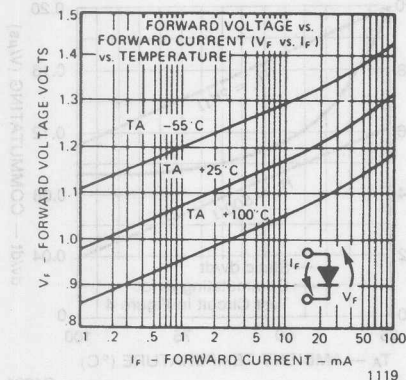
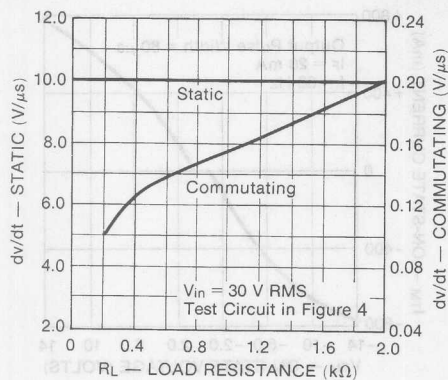


Fig. 4. dv/dt Test Circuits

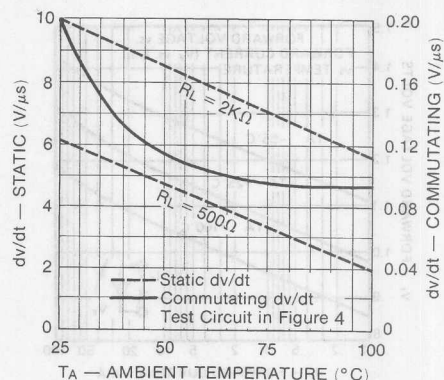
TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



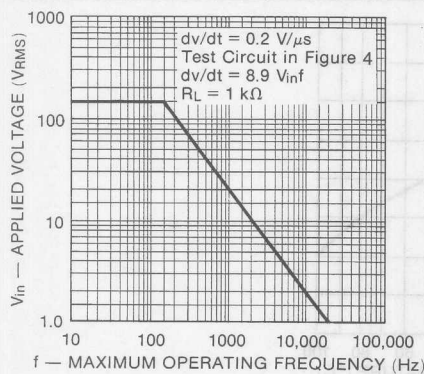
C1690

Fig. 5. dV/dt vs. Load Resistance



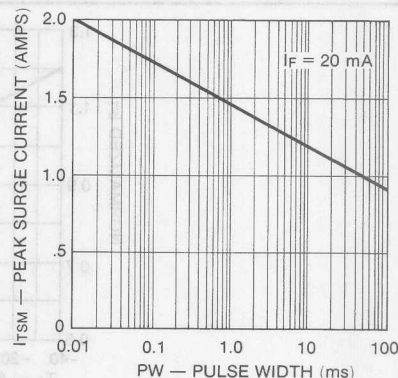
C1691

Fig. 6. dV/dt vs. Temperature



C1692

Fig. 7. Commutating dV/dt vs. Frequency



C1696

Fig. 8. Maximum Nonrepetitive Surge Current

TYPICAL APPLICATION CIRCUITS

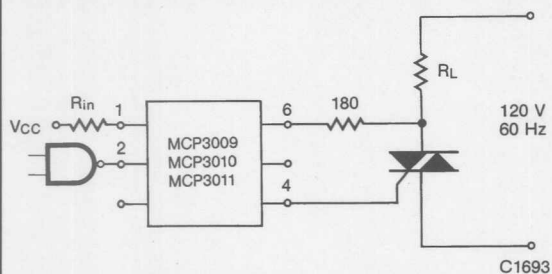


Fig. 9. Resistive Load

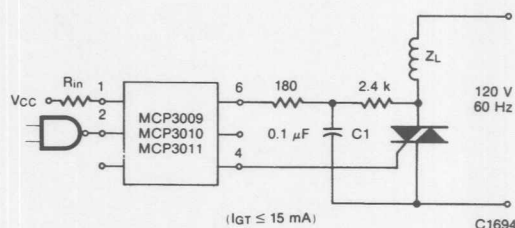


Fig. 10. Inductive Load With Sensitive Gate Triac

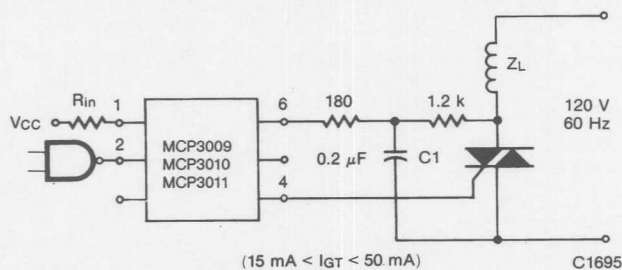
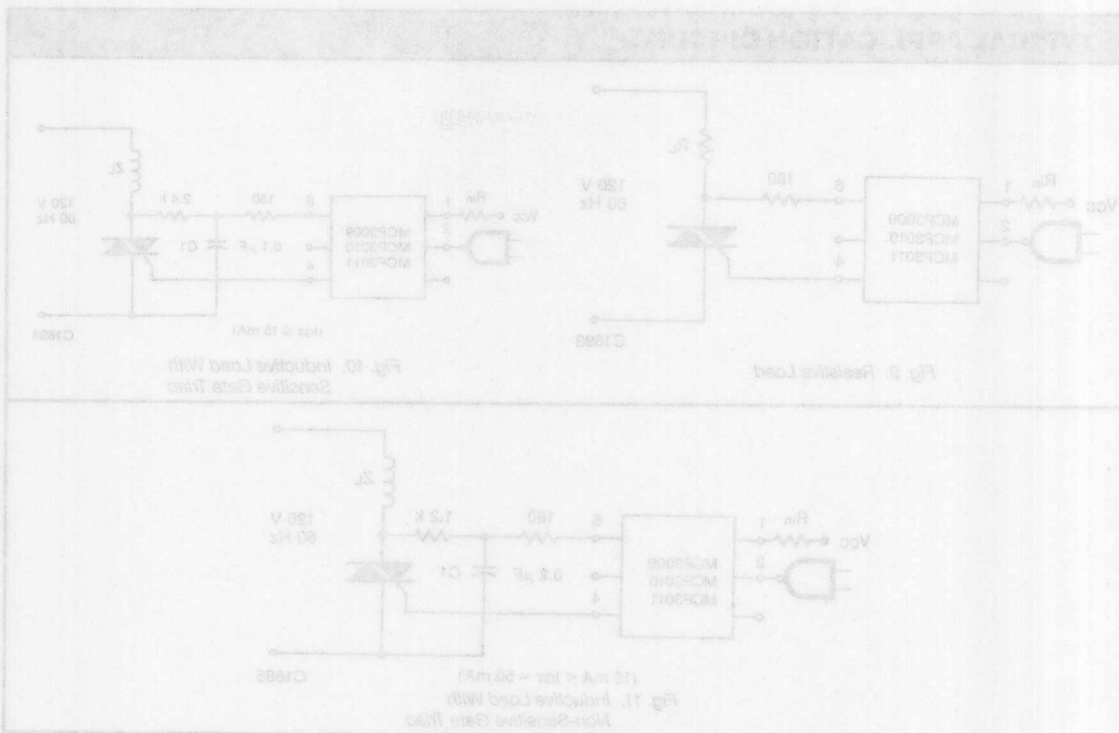
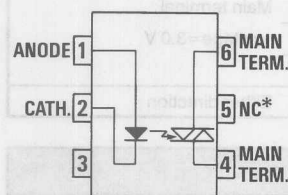
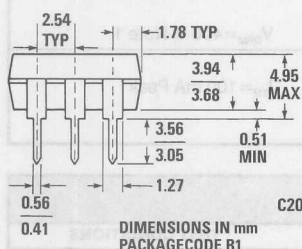
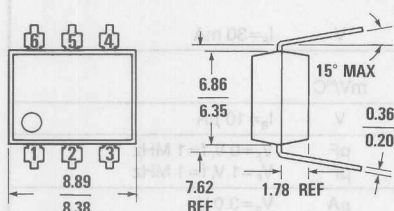


Fig. 11. Inductive Load With Non-Sensitive Gate Triac



**MCP3020 MCP3021
MCP3022**

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The MCP3020, MCP3021 and MCP3022 are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. This is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 240 VAC operations.

FEATURES

- Minimum commutating dv/dt is specified at 0.1 V/μsec
- Excellent I_{FT} stability—IR emitting diode has low degradation
- Pin for pin replacement for the MOC3020, MOC3021 and MOC3022
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized—File #E50151

APPLICATIONS

- European applications for 240 VAC
- Triac driver
- Industrial controls
- Traffic lights
- Vending machines
- Motor control
- Solid state relay

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−40°C to 100°C
Lead temperature	
(soldering, 10 sec)	260°C
Total package power dissipation @ 25°C	
(LED plus detector)	330 mW
Derate linearly from 25°C	4.0 mW/°C
Surge isolation voltage	7500 VAC Peak

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	3 V
Peak forward current	
(1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.33 mW/°C

OUTPUT DRIVER

Off-state output terminal voltage	400 Volts
On-state RMS current	$T_A=25^\circ\text{C}$ 100 mA
(Full cycle, 50 to 60 Hz)	$T_A=70^\circ\text{C}$ 50 mA
Peak nonrepetitive surge current	1.2 A
(PW=10 ms, DC=10%)	
Total power dissipation @ $T_A=25^\circ\text{C}$	300 mW
Derate above 25°C	4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F = 30 \text{ mA}$
Forward voltage temperature coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse breakdown voltage	BV_R	3.0	25		V	$I_R = 10 \text{ } \mu\text{A}$
Junction capacitance	C_J		50 65		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$ $V_F = 1 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R		.35	10	μA	$V_R = 3.0 \text{ V}$
OUTPUT DETECTOR						
Peak blocking current, either direction	I_{DRM}	—	10	100	nA	$V_{DRM} = 400 \text{ V}$, Note 1
Peak on-state voltage, either direction	V_{TM}	—	2.0	3.0	Volts	$I_{TM} = 100 \text{ mA Peak}$

Note 1. Test voltage must be applied within dv/dt rating.

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
LED trigger current (current required to latch output)	MCP3020 I_{FT}	—	15	30	mA	Main terminal
	MCP3021 I_{FT}	—	8	15	mA	voice=3.0 V
	MCP3022 I_{FT}	—	5	10	mA	
Holding current	I_H	—	200	—	μA	Either direction

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
dv/dt RATING						
Critical rate of rise of off-state voltage	dv/dt	—	15	—	V/ μs	Static dv/dt, $T_A = 85^\circ\text{C}$ (see Fig. 3)
Critical rate of rise of commutating voltage	dv/dt	0.1	0.2	—	V/ μs	Commutating dv/dt $I_{LOAD} = 15 \text{ mA}$ (see Fig. 4)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{iso}	5300			$V_{AC RMS}$	$I_{IO} \leq 1 \text{ } \mu\text{A}$, 1 minute
	V_{iso}	7500			$V_{AC PEAK}$	$I_{IO} \leq 1 \text{ } \mu\text{A}$, 1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{IO} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f = 1 \text{ MHz}$

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

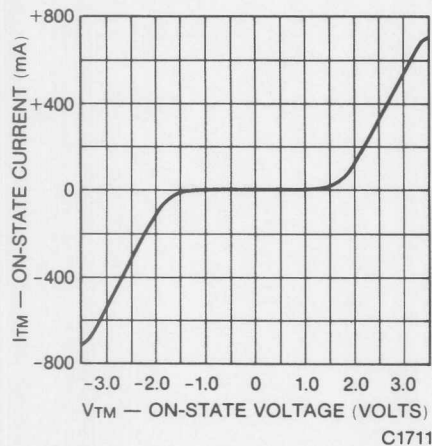


Fig. 1. On-State Characteristics

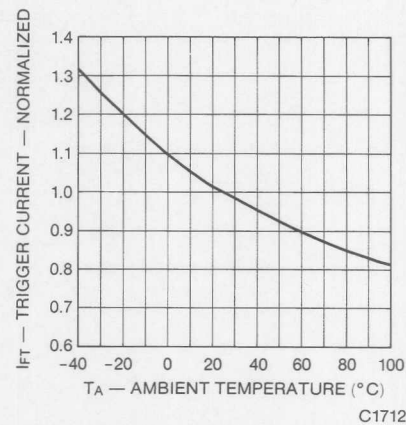
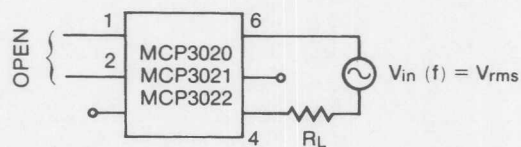


Fig. 2. Trigger Current vs. Temperature

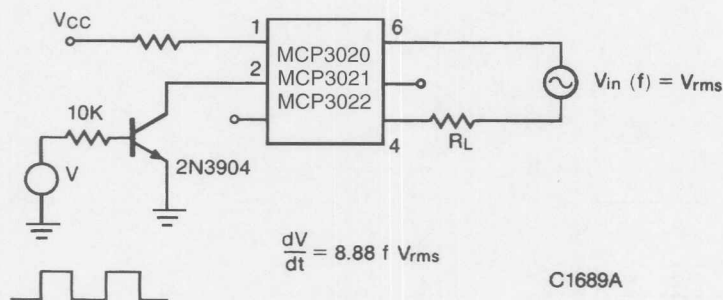
TEST CIRCUITS FOR dV/dt MEASUREMENTS



$$\frac{dV}{dt} = \omega V_{\text{pack}} = 2\pi f \times 1.414 V_{\text{rms}}$$

$$= 8.88 f V_{\text{rms}}$$

Fig. 3. Static dV/dt



$$\frac{dV}{dt} = 8.88 f V_{\text{rms}}$$

C1689A

Fig. 4. Commutating dV/dt

TYPICAL ELECTRICAL CHARACTERISTICS

Test Conditions: $V_M = 0$, $f = 50$ Hz, $V_{MT} = 0$, $V_{MT} = 0$

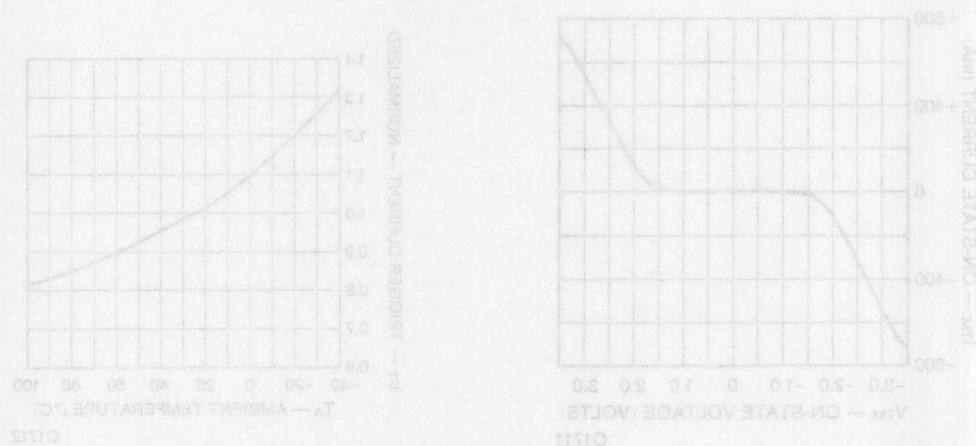


Fig. 1. On-State Characteristics

Fig. 2. Power Current vs. Temperature

TEST CIRCUITS FOR ON-STATE MEASUREMENT

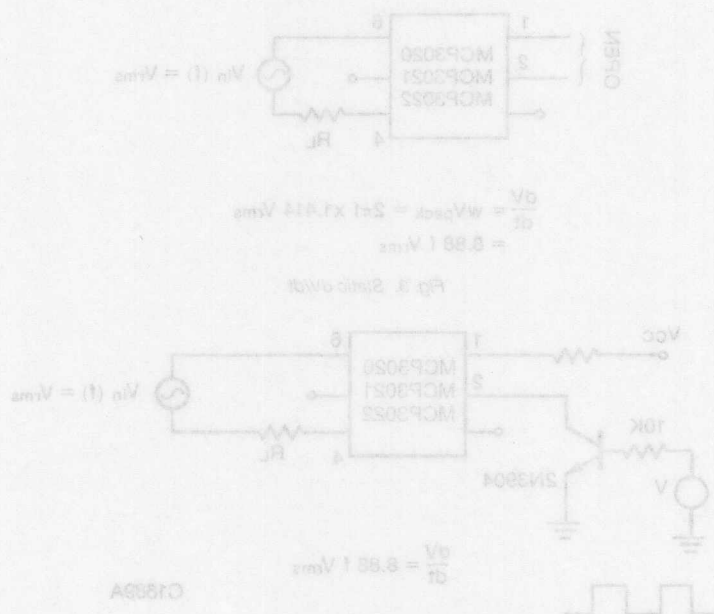
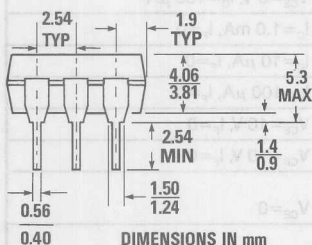
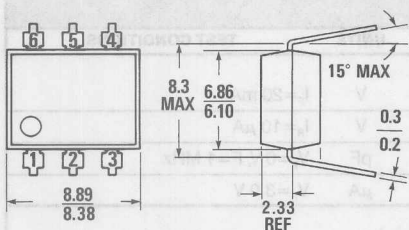


Fig. 4. Commutation dv/dt

Fig. 3. Static On-Test

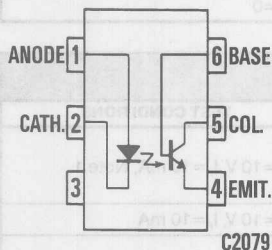
MCT2

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



Equivalent Circuit

DESCRIPTION

The MCT2 is a NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- UL recognized—File E90700

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead soldering temperature (10 sec) 260°C

INPUT DIODE

Forward current 60 mA
Reverse voltage 3.0 V
Peak forward current
(1 μ s pulse, 300 pps) 3.0 A
Power dissipation 25°C ambient 200 mW
Derate linearly from 25°C 2.6 mW/°C

OUTPUT TRANSISTOR

Power dissipation at 25°C ambient 200 mW
Derate linearly from 25°C 2.6 mW/°C
Total package power dissipation at 25°C ambient
(LED plus detector) 250 mW
Derate linearly from 25°C 3.3 mW/°C
Collector-emitter current (I_{CE}) 50 mA

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.25	1.50	V	$I_F = 20 \text{ mA}$
Reverse voltage	V_R	3.0	25		V	$I_R = 10 \text{ } \mu\text{A}$
Junction capacitance	C_J		50		pF	$V_F = 0 \text{ V}$, $F = 1 \text{ MHz}$
Reverse leakage current	I_R		.01	10	μA	$V_R = 3.0 \text{ V}$
DETECTOR						
DC forward current gain	h_{FE}		250			$V_{CE} = 5 \text{ V}$, $I_C = 100 \text{ } \mu\text{A}$
Collector to emitter breakdown volt	BV_{CEO}	30	85		V	$I_C = 1.0 \text{ mA}$, $I_F = 0$
Collector to base breakdown voltage	BV_{CBO}	70	165		V	$I_C = 10 \text{ } \mu\text{A}$, $I_F = 0$
Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	$I_E = 100 \text{ } \mu\text{A}$, $I_F = 0$
Collector to emitter, leakage current	I_{CEO}		5	50	nA	$V_{CE} = 10 \text{ V}$, $I_F = 0$
Collector to base leakage current	I_{CBO}		0.1	20	nA	$V_{CB} = 10 \text{ V}$, $I_F = 0$
Capacitance collector to emitter	C_{CEO}		8		pF	$V_{CE} = 0$
Capacitance collector to base	C_{CBO}		20		pF	$V_{CB} = 10 \text{ V}$
Capacitance emitter to base	C_{EBO}		10		pF	$V_{BE} = 0$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
COUPLED						
DC collector current transfer ratio	CTR_{CE}	20	60		%	$V_{CE} = 10 \text{ V}$, $I_F = 10 \text{ mA}$, Note 1
DC base current transfer ratio	CTR_{CB}		.35		%	$V_{CB} = 10 \text{ V}$, $I_F = 10 \text{ mA}$
Collector-emitter, saturation voltage	$V_{CE}(\text{sat})$		0.24	0.4	V	$I_C = 2.0 \text{ mA}$, $I_F = 16 \text{ mA}$

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Bandwidth (see note 2)	B_W		150		KHz	$I_C = 2 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $R_L = 100 \Omega$
SWITCHING TIMES						
Saturated						
t on (from 5 V to 0.8 V)	$t_{on}(\text{SAT})$		10		μs	$R_L = 2 \text{ K}\Omega$, $I_F = 15 \text{ mA}$, $V_{CC} = 5 \text{ V}$
t off (from SAT to 2.0 V)	$t_{off}(\text{SAT})$		30		μs	$R_B = \text{open}$ (Fig. 10 and Fig. 11)
Saturated						
t on (from 5 V to 0.8 V)	$t_{on}(\text{SAT})$		10		μs	$R_L = 2 \text{ K}\Omega$, $I_F = 20 \text{ mA}$, $V_{CC} = 5 \text{ V}$
t off (from SAT to 2.0 V)	$t_{off}(\text{SAT})$		27		μs	$R_B = 100 \text{ K}\Omega$ (Fig. 10 and Fig. 11)
Non-saturated						
Base	Rise Time		300		ns	$R_L = 1 \text{ K}\Omega$, $V_{CB} = 10 \text{ V}$
	Fall Time		300		ns	

ELECTRO-OPTICAL CHARACTERISTICS

25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage		7500			VAC PEAK	1 minute
		5300			VRMS	1 minute
Isolation resistance		10^{11}	10^{12}		Ω	$V_{i0}=500\text{ V}$
Isolation capacitance			.5		pF	f=1 MHz

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

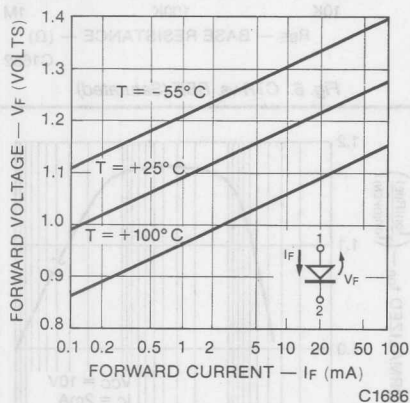


Fig. 1. Forward Voltage vs. Current

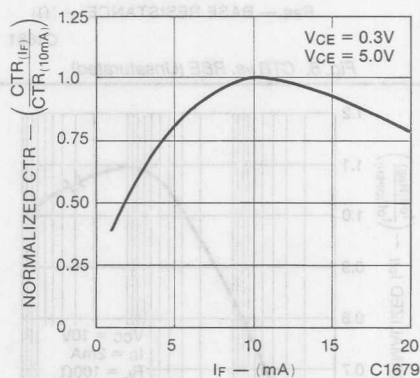


Fig. 2. Normalized CTR vs. Forward Current

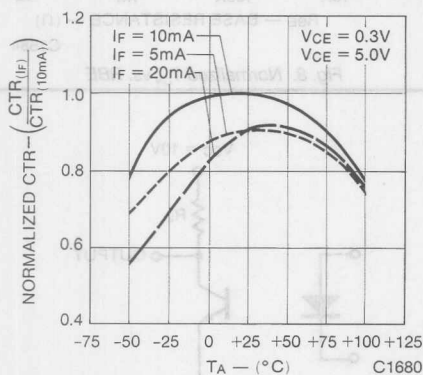


Fig. 3. Normalized CTR vs. Temperature

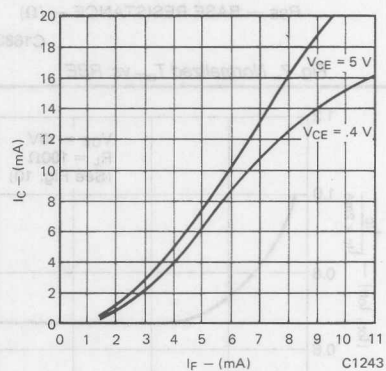


Fig. 4. Collector Current vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

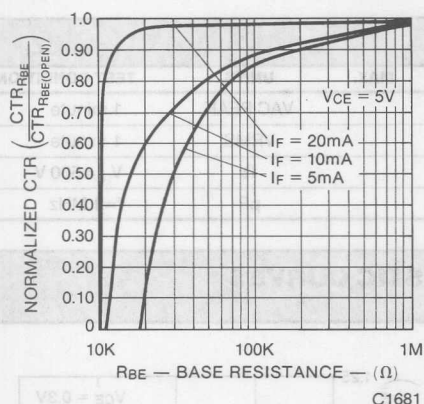


Fig. 5. CTR vs. RBE (Unsaturated)

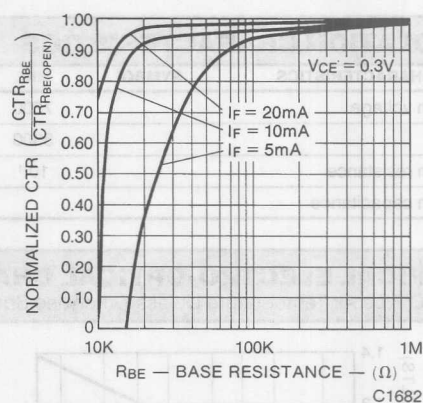


Fig. 6. CTR vs. RBE (Saturated)

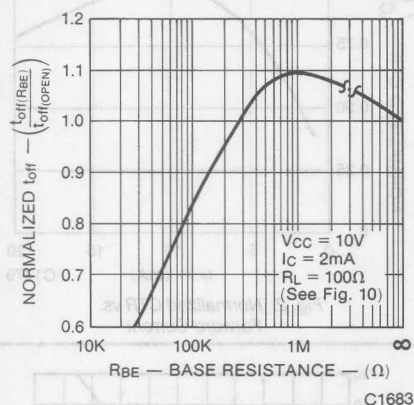


Fig. 7. Normalized T_{OFF} vs. RBE

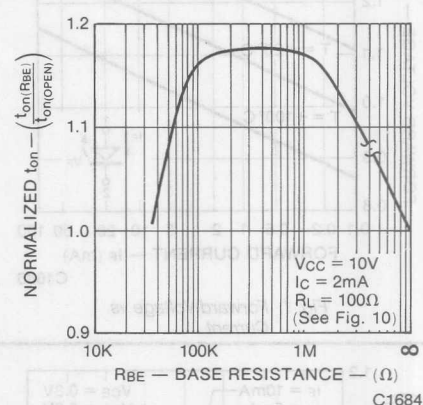


Fig. 8. Normalized T_{ON} vs. RBE

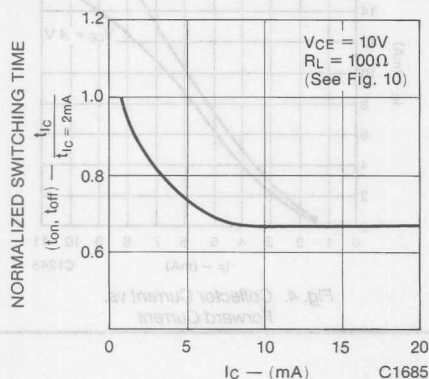


Fig. 9. Switching Time vs. I_C

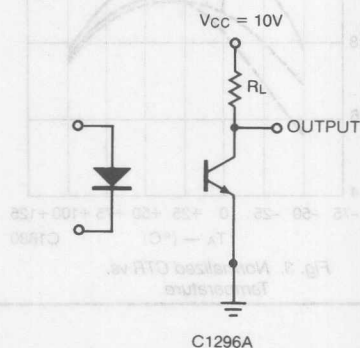


Fig. 10. Switching Time Test Circuit

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

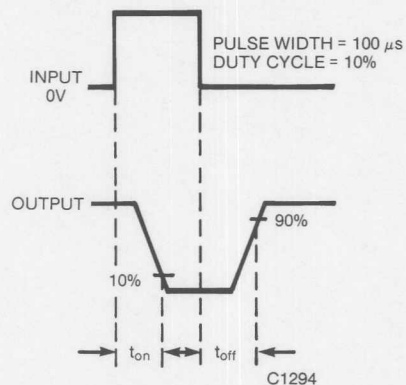


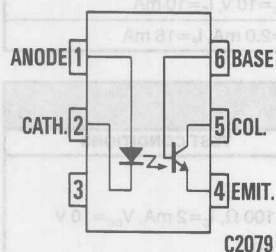
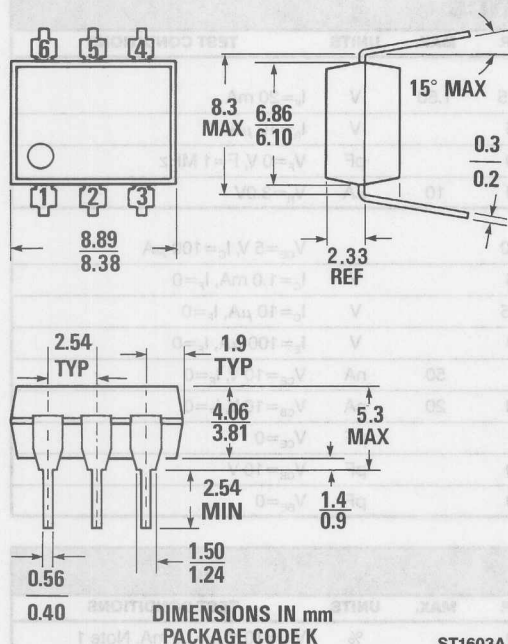
Fig. 11. Switching Time Waveforms

NOTES

1. The current transfer ratio (I_o/I_e) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
2. The frequency at which i_c is 3 dB down from the 1 kHz value.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.
Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value, to 10%.

MCT2E

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The MCT2E is a NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES & APPLICATIONS

- Utility/economy isolator
- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- UL recognized — File E90700

ABSOLUTE MAXIMUM RATINGS

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead soldering temperature (10 sec) 260°C

INPUT DIODE

Forward current 60 mA
Reverse voltage 3.0 V
Peak forward current
(1 μ s pulse, 300 pps) 3.0 A

Power dissipation at 25°C ambient 200 mW
Derate linearly from 25°C 2.6 mW/°C

OUTPUT TRANSISTOR

Power dissipation at 25°C ambient 200 mW
Derate linearly from 25°C 2.6 mW/°C
Total package power dissipation at 25°C ambient
(LED plus detector) 250 mW
Derate linearly from 25°C 3.3 mW/°C
Collector-Emitter Current (I_{CE}) 50 mA

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.25	1.50	V	$I_F=20\text{ mA}$
Reverse voltage	V_R	3.0	25		V	$I_R=10\text{ }\mu\text{A}$
Junction capacitance	C_J		50		pF	$V_F=0\text{ V}$, $F=1\text{ MHz}$
Reverse leakage current	I_R		.01	10	μA	$V_R=3.0\text{ V}$
OUTPUT TRANSISTOR						
DC forward current gain	h_{FE}	100	250			$V_{CE}=5\text{ V}$, $I_C=100\text{ }\mu\text{A}$
Collector to emitter breakdown volt.	BV_{CEO}	30	85		V	$I_C=1.0\text{ mA}$, $I_F=0$
Collector to base breakdown voltage	BV_{CBO}	70	165		V	$I_C=10\text{ }\mu\text{A}$, $I_F=0$
Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	$I_E=100\text{ }\mu\text{A}$, $I_F=0$
Collector to emitter, leakage current	I_{CEO}		5	50	nA	$V_{CE}=10\text{ V}$, $I_F=0$
Collector to base leakage current	I_{CBO}		0.1	20	nA	$V_{CB}=10\text{ V}$, $I_F=0$
Capacitance collector to emitter	C_{CEO}		8		pF	$V_{CE}=0$
Capacitance collector to base	C_{CBO}		20		pF	$V_{CB}=10\text{ V}$
Capacitance emitter to base	C_{EBO}		10		pF	$V_{BE}=0$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC collector current transfer ratio	CTR_{CE}	20	60		%	$V_{CE}=10\text{ V}$, $I_F=10\text{ mA}$, Note 1
DC base current transfer ratio	CTR_{CB}		.35		%	$V_{CB}=10\text{ V}$, $I_F=10\text{ mA}$
Collector-emitter, saturation voltage	$V_{CE}(\text{sat})$		0.24	0.4	V	$I_C=2.0\text{ mA}$, $I_F=16\text{ mA}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated collector						
Delay time	t_d		0.5		μs	$R_L=100\text{ }\Omega$, $I_C=2\text{ mA}$, $V_{CC}=10\text{ V}$
Rise time	t_r		2.5		μs	Fig. 10
Storage time	t_s		0.1		μs	
Fall time	t_f		2.6		μs	
Saturated collector						
Delay time	t_d		2.0		μs	$R_L=1\text{ K}\Omega$, $I_C=2\text{ mA}$, $V_{CC}=10\text{ V}$
Rise time	t_r		15		μs	
Storage time	t_s		0.1		μs	
Fall time	t_f		15		μs	

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS (Cont'd)

	SYMBOL	TYP.	UNITS	TEST CONDITIONS
SWITCHING TIMES (Cont'd)				
Saturated				
t on (from 5 V to 0.8 V)	t_{on} (SAT)	5	μ S	$R_L = 2\text{ K}\Omega$, $I_F = 15\text{ mA}$, $V_{CC} = 5\text{ V}$
t off (from SAT to 2.0 V)	t_{off} (SAT)	25		$R_B = \text{open}$
Saturated				
t on (from 5 V to 0.8 V)	t_{on} (SAT)	5	μ S	$R_L = 2\text{ K}\Omega$, $I_F = 20\text{ mA}$, $V_{CC} = 5\text{ V}$
t off (from SAT to 2.0 V)	t_{off} (SAT)	18		$R_B = 100\text{ K}\Omega$
Non-saturated				
Base				
Rise time	t_r	175	ns	$R_L = 1\text{ K}\Omega$, $V_{CB} = 10\text{ V}$
Fall time	t_f	175	ns	
Bandwidth (see note 2)	B_w	150	KHz	$I_C = 2\text{ mA}$, $V_{CE} = 10\text{ V}$, $R_i = 100\Omega$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Steady state isolation voltage	V_{iso}	7500			VAC-PEAK	$I_{L0} \leq 1\text{ }\mu\text{A}$, 1 minute
		5300			VAC-rms	$I_{L0} \leq 1\text{ }\mu\text{A}$, 1 minute
Isolation resistance		10^{11}	10^{12}		Ω	$V_{L0} = 500\text{ V}$
Isolation capacitance			.5		pF	$F = 1\text{ MHz}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

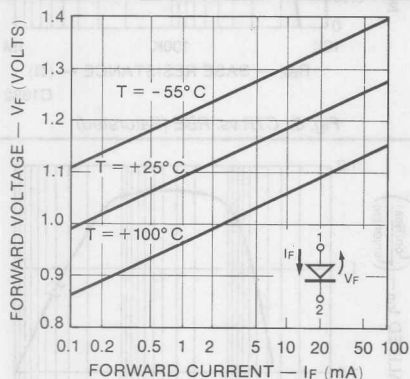


Fig. 1. Forward Voltage vs. Current

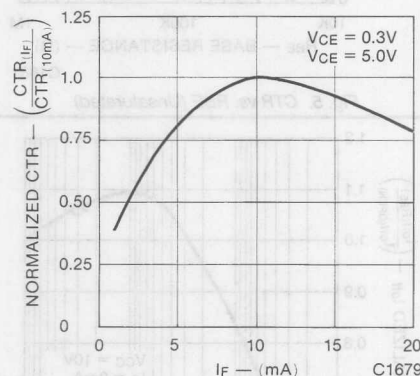
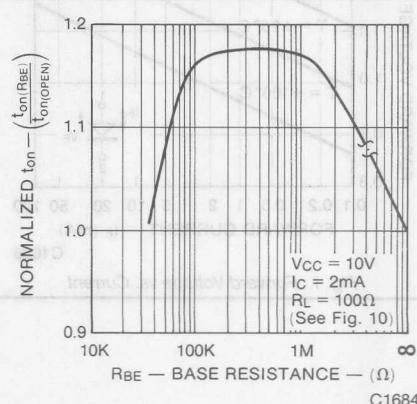
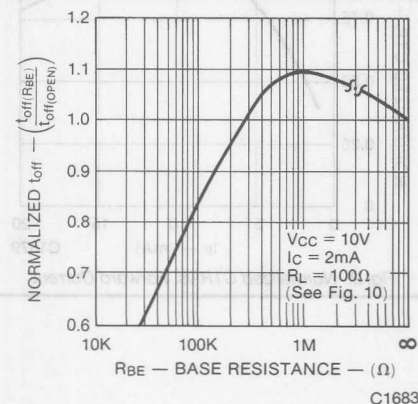
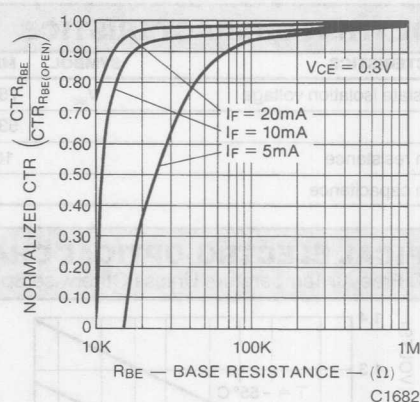
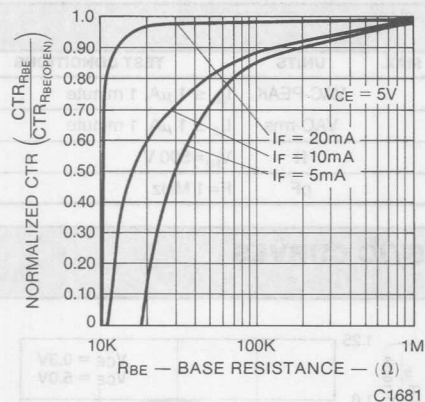
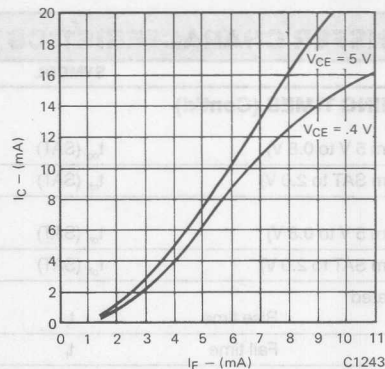
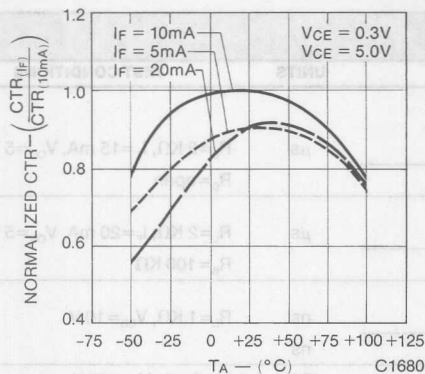


Fig. 2. Normalized CTR vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

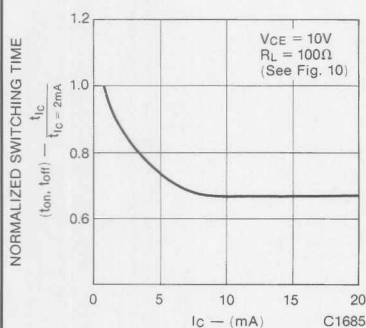


Fig. 9. Switching Time vs. IC

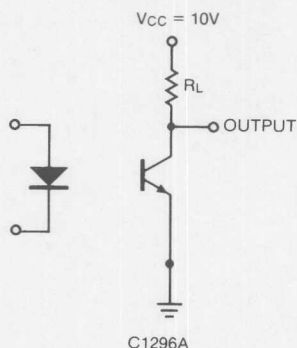


Fig. 10. Switching Time Test Circuit

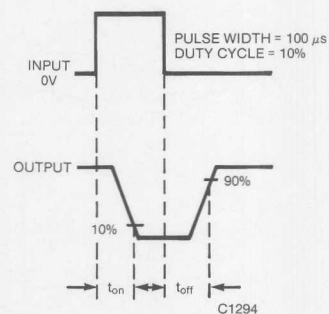
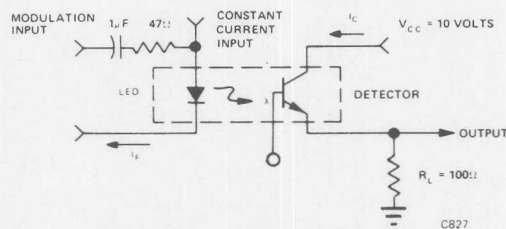


Fig. 11. Switching Time Waveforms

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs. Frequency Plot

NOTES

1. The current transfer ratio (I_O/I_E) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
2. The frequency at which i_c is 3 dB down from the 1 kHz value.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%.
Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value, to 10%.

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

Fig. 9. Typical Collector Current vs. Collector Voltage

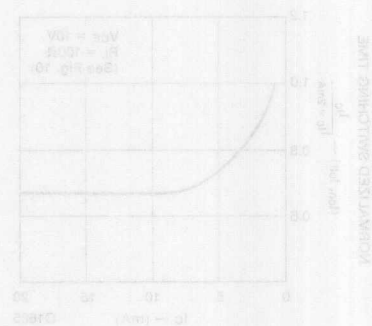
Fig. 9. Switching Time vs. I_C 

Fig. 10. Switching Time Test Circuit

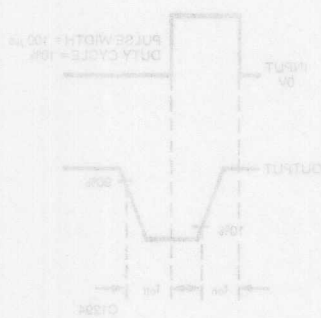
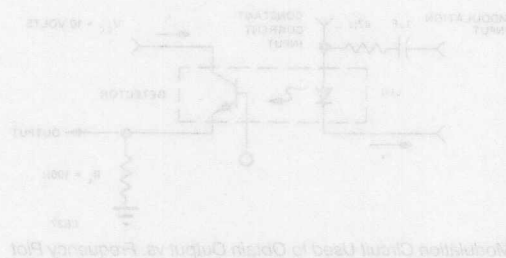


Fig. 11. Switching Time Waveforms

OPERATING SCHEMATIC



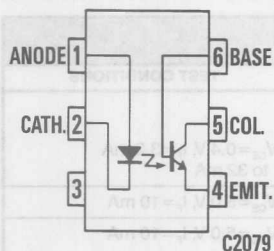
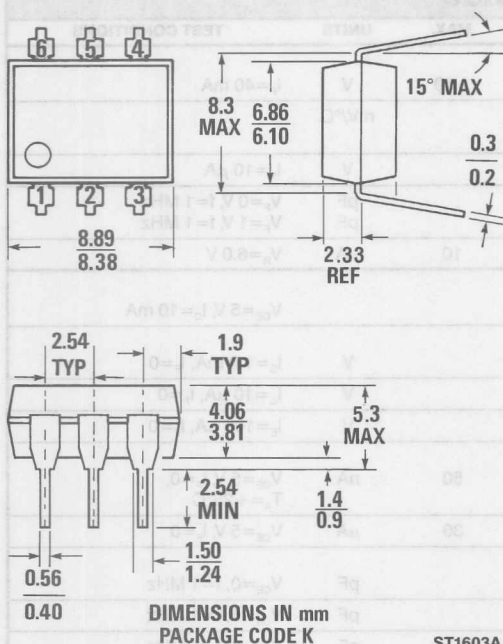
Modulation Circuit Used to Obtain Output vs. Frequency Plot

NOTES

1. The current transfer ratio (I_{CS}/I_{C0}) is the ratio of the detector collector current to the LED input current with V_{CC} at 10 volts.
2. The frequency at which I_{CS}/I_{C0} is 3 dB down from the 1 kHz value.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%.
4. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

MCT210

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The MCT210 incorporates a NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode. The MCT210 has a specified minimum CTR of 50%, saturated, and 150%, unsaturated.

FEATURES

- TTL compatible 1-10 gate loads
- High CTR with transistor output MCT210—150% min.
- Specified CTR over temperature range
- Good logic load characteristics
 $V_{OL} = 0.4 \text{ V @ } 1.6 \text{ mA to } 16 \text{ mA}$
output sinking (I_{OL})
- UL recognized (File #E90700)

APPLICATIONS

- Digital logic isolation
- Line receivers
- Feedback control circuits
- Monitoring circuits

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.4 mW/°C

INPUT DIODE

Forward current	60 mA
Reverse voltage	3.0 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C to 70° ambient	90 mW
Derate linearly from +70°C	2.0 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS

(0° to +70°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.25	1.50	V	$I_F = 40 \text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse breakdown voltage	BV_R	6.0	15		V	$I_R = 10 \text{ } \mu\text{A}$
Junction capacitance	C_J		50		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
			65		pF	$V_F = 1 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R		.01	10	μA	$V_R = 6.0 \text{ V}$
OUTPUT TRANSISTOR						
DC forward current gain	h_{FE}		400			$V_{CE} = 5 \text{ V}, I_C = 10 \text{ mA}$
Breakdown voltage						
Collector to emitter	BV_{CEO}	30	45		V	$I_C = 1.0 \text{ mA}, I_F = 0$
Collector to base	BV_{CBO}	30			V	$I_C = 10 \text{ } \mu\text{A}, I_F = 0$
Emitter to collector	BV_{ECO}	6	8		V	$I_E = 100 \text{ } \mu\text{A}, I_F = 0$
Leakage current						
Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 5 \text{ V}, I_F = 0, T_A = +25^\circ\text{C}$
				30	μA	$V_{CE} = 5 \text{ V}, I_F = 0$
Capacitance						
Collector to emitter			8		pF	$V_{CE} = 0, f = 1 \text{ MHz}$
Collector to base			20		pF	$V_{CB} = 5, f = 1 \text{ MHz}$
Emitter to base			10		pF	$V_{EB} = 0, f = 1 \text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current transfer ratio, collector to emitter MCT210 (a)	I_{CE}/I_F	50	70		%	$V_{CE} = 0.4 \text{ V}, I_F = 3.2 \text{ mA}$ to 32 mA
		150	225		%	$V_{CE} = 5.0 \text{ V}, I_F = 10 \text{ mA}$
Current transfer ratio, collector to base	I_{CB}/I_F		0.6		%	$V_{CB} = 5.0 \text{ V}, I_F = 10 \text{ mA}$
Saturation voltage collector to emitter	$V_{CE(SAT)}$		0.2	0.4	V	$I_C = 16 \text{ mA}, I_F = 32 \text{ mA}$

ELECTRO-OPTICAL CHARACTERISTICS

(0° to +70°C Temperature Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS (Cont'd)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated Rise time	t_r		4		μs	$R_L = 100 \Omega$, $I_C = 2 \text{ mA}$, $V_{CC} = 5 \text{ V}$
Fall time	t_f		5		μs	See Figs. 15 and 16
Saturated Rise time	t_r		2.5		μs	$R_L = 560 \Omega$, $I_F = 16 \text{ mA}$
Fall time	t_f		25		μs	See Figs. 15 and 16
Propagation delay High to low	$T_{PD(HL)}$		2		μs	$R_L = 2.7 \text{ K}$, $I_F = 16 \text{ mA}$
Low to high	$T_{PD(LH)}$		10		μs	See Figs. 15 and 16

ISOLATION CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Steady state isolation	V_{ISO}	7500			VAC-PEAK	$I_{IO} \leq 1 \mu\text{A}$, 1 minute
		5300			VAC-RMS	$I_{IO} \leq 1 \mu\text{A}$, 1 minute
Isolation resistance	R_{ISO}	10^{11}	5×10^{12}		ohms	$V_{IO} = 500 \text{ VDC}$, $T_A = +25^\circ\text{C}$
Isolation capacitance	C_{ISO}		1.0		pF	$f = 1 \text{ MHz}$

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

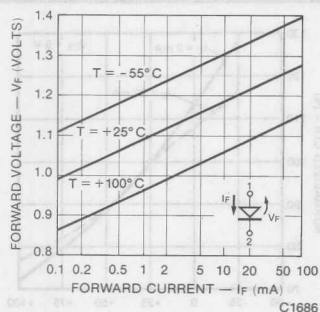


Fig. 1. Forward Voltage vs.
Forward Current

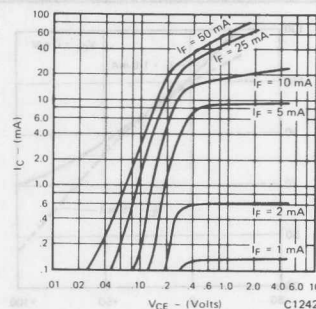


Fig. 2. Collector Current vs.
Collector to Emitter Voltage

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

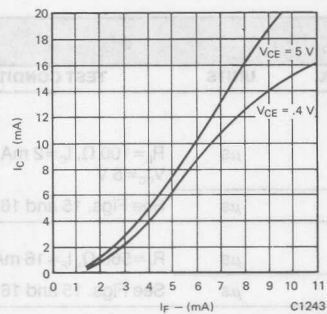


Fig. 3. Collector Current vs. Forward Current

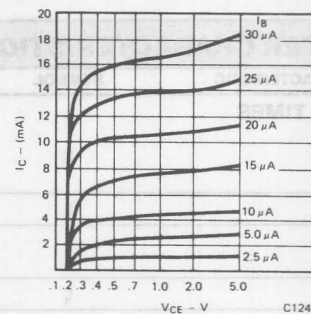


Fig. 4. Collector Current vs. Collector to Emitter Voltage

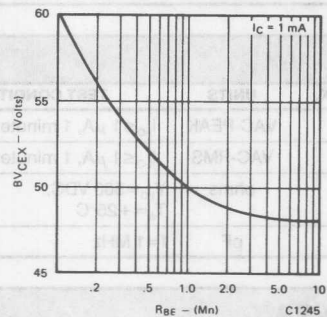


Fig. 5. Collector to Emitter Breakdown Voltage vs. Base to Emitter Resistance

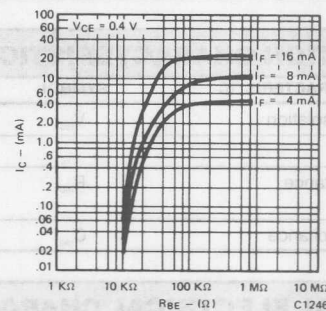


Fig. 6. Saturated CTR vs. Base to Emitter Resistance

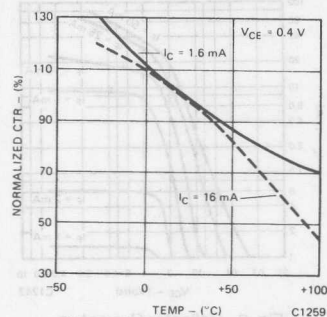


Fig. 7. Current Transfer Ratio (saturated) vs. Temperature

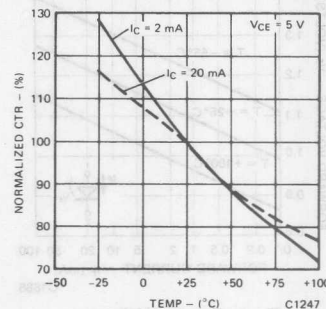


Fig. 8. Current Transfer Ratio (unsaturated) vs. Temperature

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

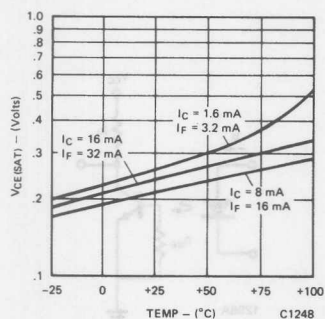


Fig. 9. Collector to Emitter Saturation Voltage vs. Temperature

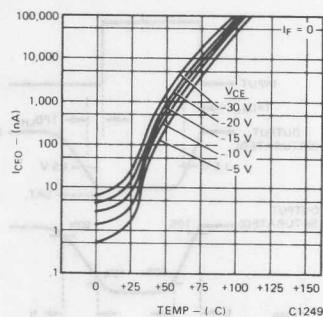


Fig. 10. Collector to Emitter Leakage Current vs. Temperature

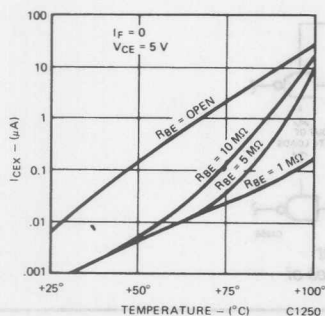


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

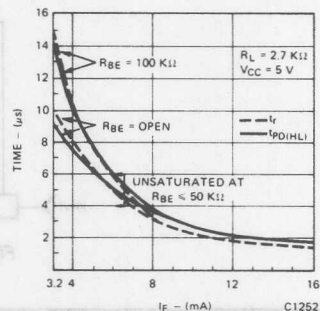


Fig. 12. Switch-on Time vs. I_F Drive (saturated)

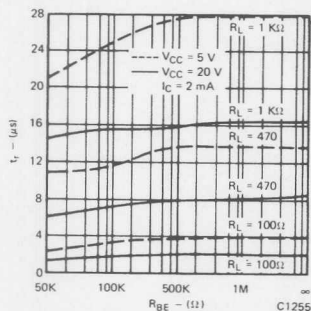


Fig. 13. Rise Time vs. Base to Emitter Resistance (non-saturated)

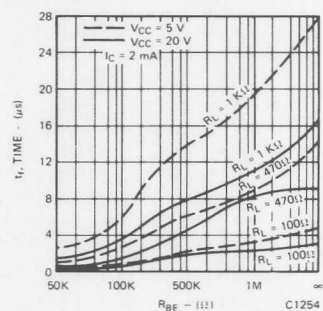


Fig. 14. Fall Time vs. Base to Emitter Resistance (non-saturated)

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

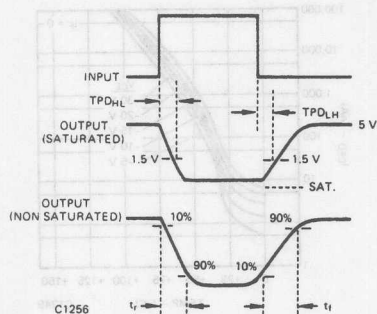


Fig. 15 Switching Time Waveforms

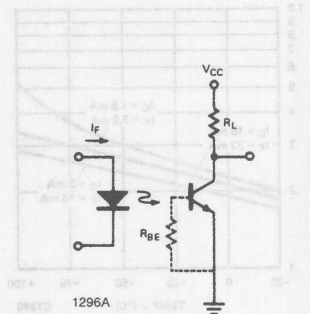


Fig. 16 Switching Time Test Circuits

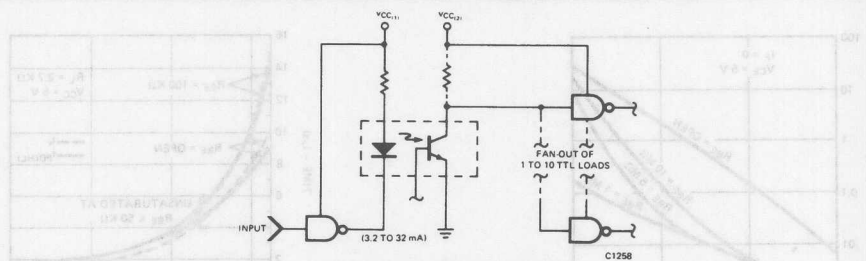
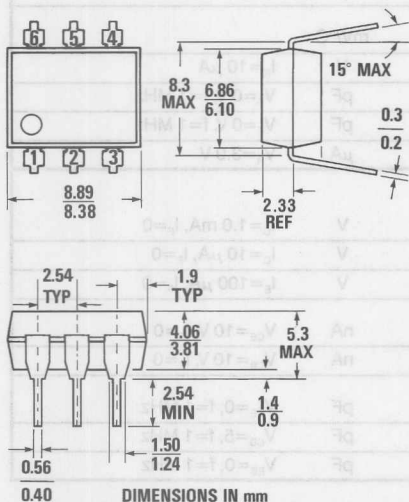


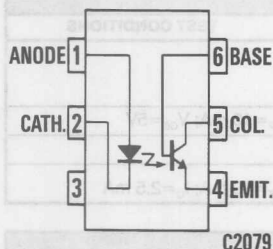
Fig. 17. Typical TTL Interface at Operating Temperatures of 0° to 70°C

MCT2200
MCT2201
MCT2202

PACKAGE DIMENSIONS



ST1603A



Equivalent Circuit

DESCRIPTION

The MCT2200, MCT2201 and MCT2202 are opto-isolators with phototransistor output. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- Minimum current transfer ratio of 100%
- Maximum turn-on, turn-off time — 10 μ s
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	—55°C to 150°C
Operating temperature	—55°C to 100°C
Lead soldering temperature (10 sec.)	260°C
Total package power dissipation at 25°C ambient (LED plus detector)	260 mW
Derate linearly from 25°	3.5 mW/°C

INPUT DIODE

Forward current	60 mA
Reverse voltage	3.0 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation at 25°C ambient	135 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation at 25°C ambient	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F=20\text{ mA}$
Forward voltage temperature coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	3.0	25		V	$I_R=10\text{ }\mu\text{A}$
Junction capacitance	C_j		50		pF	$V_F=0\text{ V}, f=1\text{ MHz}$
			65		pF	$V_F=0\text{ V}, f=1\text{ MHz}$
Reverse leakage current	I_R		.35	10	μA	$V_R=3.0\text{ V}$
OUTPUT TRANSISTOR						
Breakdown voltage						
Collector to emitter	BV_{CEO}	30	45		V	$I_C=1.0\text{ mA}, I_F=0$
Collector to base	BV_{CBO}	70	130		V	$I_C=10\text{ }\mu\text{A}, I_F=0$
Emitter to base	BV_{EBO}	5	7		V	$I_E=100\text{ }\mu\text{A}, I_F=0$
Leakage current	Collector to emitter		5	50	nA	$V_{CE}=10\text{ V}, I_F=0$
						$V_{CB}=10\text{ V}, I_F=0$
Capacitance	Collector to emitter		8		pF	$V_{CE}=0, f=1\text{ MHz}$
						$V_{CB}=5, f=1\text{ MHz}$
Collector to base			20		pF	$V_{CB}=5, f=1\text{ MHz}$
Emitter to base			10		pF	$V_{EB}=0, f=1\text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio, collector to emitter MCT2200	CTR	20	60		%	
		100	200		%	$I_F=10\text{ mA}; V_{CE}=5\text{ V}$
		63	95	125	%	
Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	$I_F=10\text{ mA}; I_C=2.5\text{ mA}$

TRANSFER CHARACTERISTICS

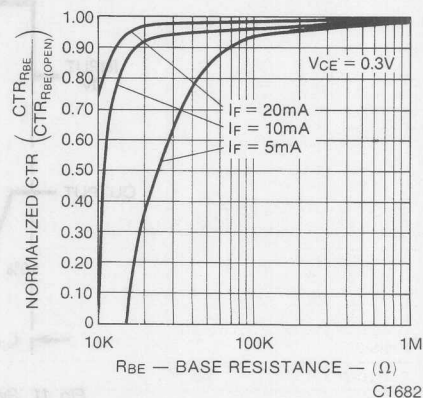
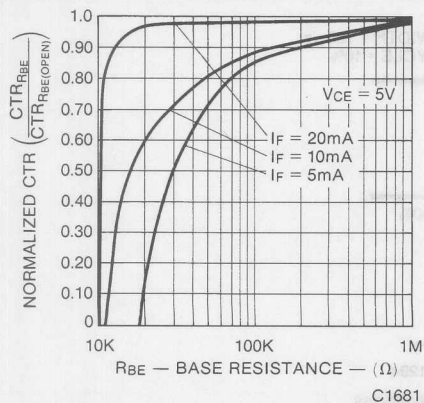
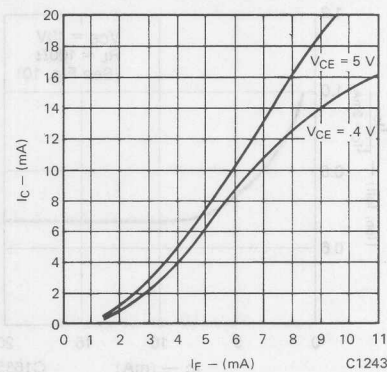
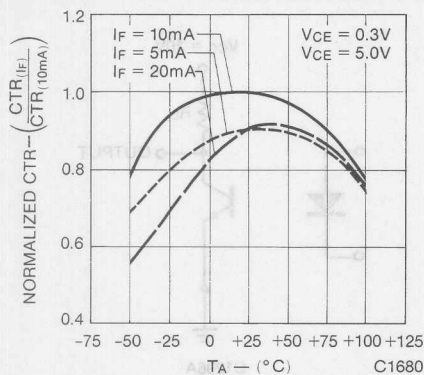
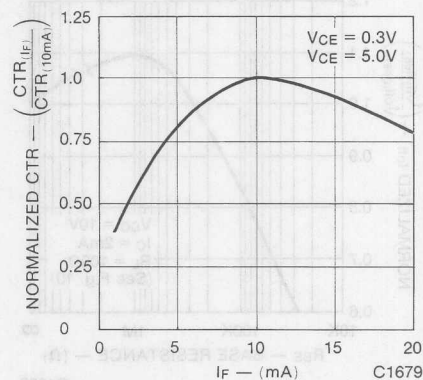
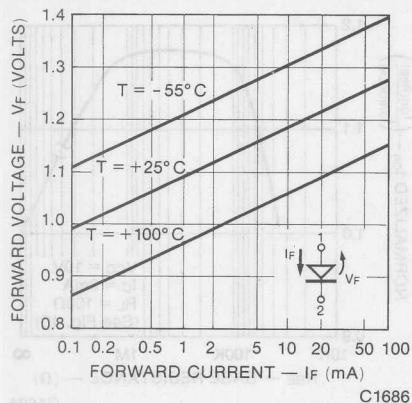
CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						$R_L=100\text{ }\Omega; I_C=2\text{ mA}; V_{CC}=10\text{ V}$
Turn-on time	t_{on}		6.0	10	μs	
Turn-off time	t_{off}		5.5	10	μs	See Figure 10.

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{iso}	5300			$V_{AC}\text{ RMS}$	$I_{IO} \leq 1\text{ }\mu\text{A}, 1\text{ minute}$
	V_{iso}	7500			$V_{AC}\text{ PEAK}$	$I_{IO} \leq 1\text{ }\mu\text{A}, 1\text{ minute}$
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{IO}=500\text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f=1\text{ MHz}$

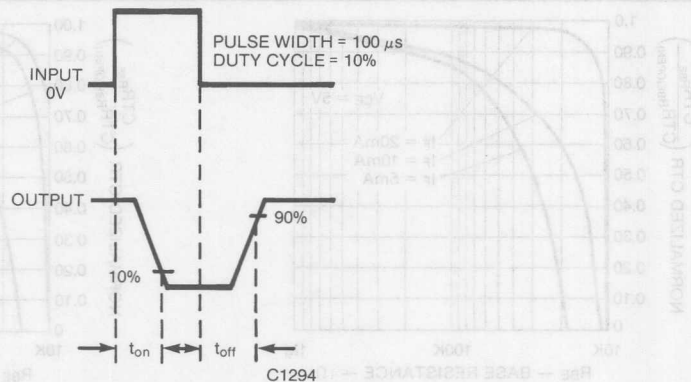
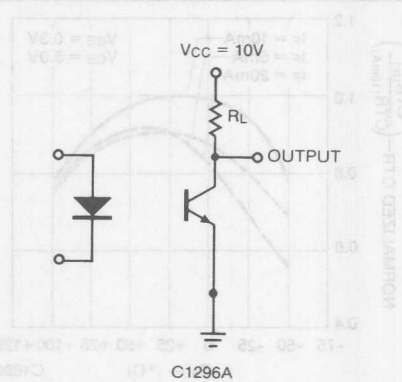
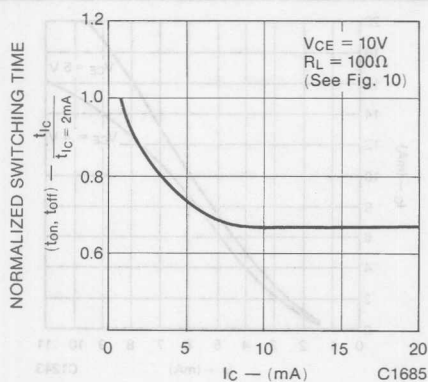
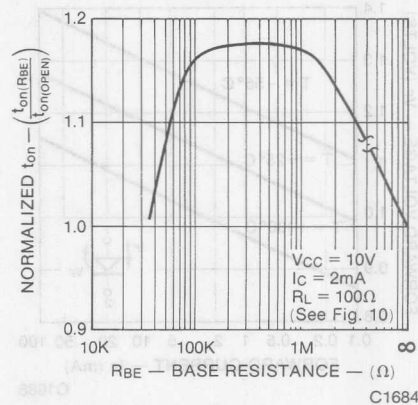
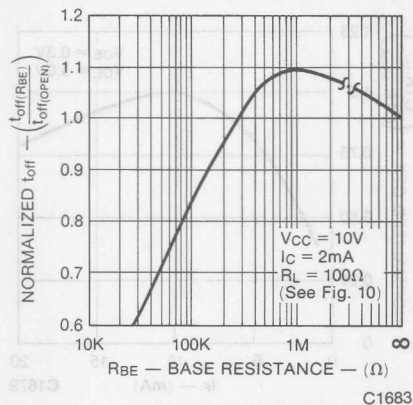
ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)



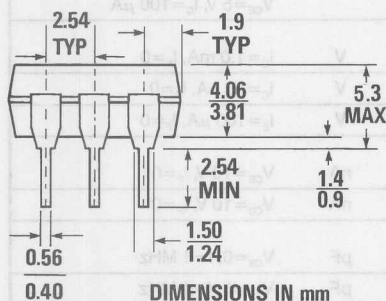
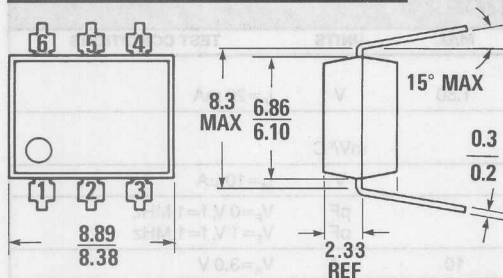
ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



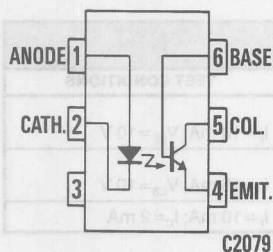
MCT270

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



Equivalent Circuit

DESCRIPTION

The MCT270 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- Minimum current transfer ratio of 50%
- Maximum turn-on, turn-off time 10 μ seconds specified
- Underwriters Laboratory (UL) recognized File E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Power supply regulators
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead temperature
(soldering, 10 sec) 260°C
Total package power dissipation @ 25
(LED plus detector) 260 mW
Derate linearly from 25°C 3.5 mW/°C

INPUT DIODE

Forward DC current 90 mA
Reverse voltage 3 V
Peak forward current
(1 μ s pulse, 300 pps) 3.0 A
Power dissipation 25°C ambient 135 mW
Derate linearly from 25°C 1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C 200 mW
Derate linearly from 25°C 2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F=20\text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	3.0	25		V	$I_R=10\text{ }\mu\text{A}$
Junction capacitance	C_j		50		pF	$V_F=0\text{ V}, f=1\text{ MHz}$
			65		pF	$V_F=1\text{ V}, f=1\text{ MHz}$
Reverse leakage current	I_R		0.35	10	μA	$V_R=3.0\text{ V}$
OUTPUT TRANSISTOR						
DC forward current gain	h_{FE}	100	500			$V_{CE}=5\text{ V}, I_C=100\text{ }\mu\text{A}$
Breakdown voltage						
Collector to emitter	BV_{CEO}	30	45		V	$I_C=1.0\text{ mA}, I_F=0$
Collector to base	BV_{CBO}	70	130		V	$I_C=10\text{ }\mu\text{A}, I_F=0$
Emitter to base	BV_{EBO}	5	7		V	$I_E=100\text{ }\mu\text{A}, I_F=0$
Leakage current						
Collector to emitter	I_{CEO}		5	50	nA	$V_{CE}=10\text{ V}, I_F=0$
Collector to base	I_{CBO}			20	nA	$V_{CB}=10\text{ V}, I_F=0$
Capacitance						
Collector to emitter			8		pF	$V_{CE}=0, f=1\text{ MHz}$
Collector to base			20		pF	$V_{CB}=5, f=1\text{ MHz}$
Emitter to base			10		pF	$V_{EB}=0, f=1\text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current transfer ratio, collector to emitter	CTR_{CE}	50	115		%	$I_F=10\text{ mA}; V_{CE}=10\text{ V}$
Current transfer ratio, collector to base	CTR_{CB}	0.045	0.15		%	$I_F=16\text{ mA}; V_{CB}=10\text{ V}$
Saturation voltage	$V_{CE(SAT)}$		.21	.40	V	$I_F=10\text{ mA}; I_C=2\text{ mA}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						
Turn-on time	t_{on}		6.0	10	μs	$R_L=100\Omega; I_C=2\text{ mA}; V_{CC}=5\text{ V}$
Turn-off time	t_{off}		5.5	10	μs	See Figs. 10, 11
Saturated						
Turn-on time	t_{on}		3.9		μs	$I_F=16\text{ mA}; R_L=1.9\text{ K}\Omega$
Turn-off time	t_{off}		48		μs	See Figs. 10, 11
(Approximates a typical TTL interface)						
Turn-on time	t_{on}		3.9		μs	$I_F=16\text{ mA}; R_L=4.7\text{ K}\Omega$
Turn-off time	t_{off}		110		μs	See Figs. 10, 11
(Approximates a typical low power TTL interface)						

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Temperature Unless Otherwise Specified) (Cont'd)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Steady state isolation	V_{ISO}	7500			VAC-PEAK	$I_{IO} \leq 1 \mu A$, 1 minute
		5300			VAC-rms	$I_{IO} \leq 1 \mu A$, 1 minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{IO} = 500$ VDC
Isolation capacitance	C_{ISO}		0.5		pF	$f = 1$ MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

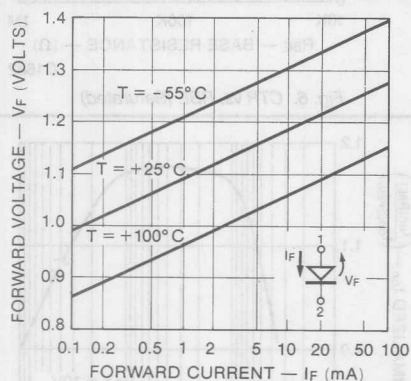


Fig. 1. Forward Voltage vs. Current

C1686

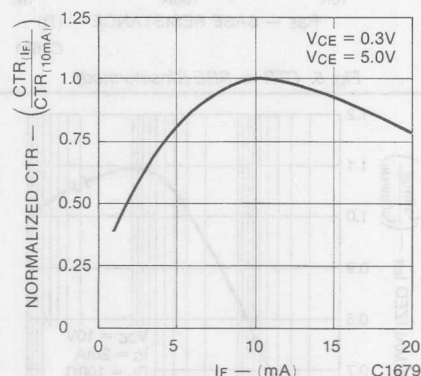


Fig. 2. Normalized CTR vs. Forward Current

C1679

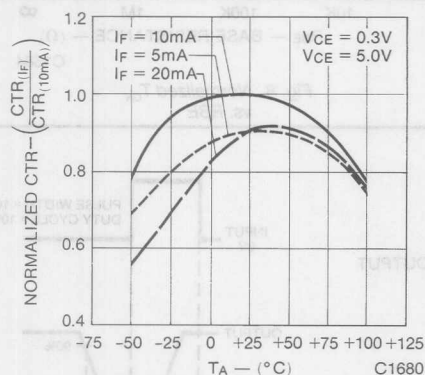


Fig. 3. Normalized CTR vs. Temperature

C1680

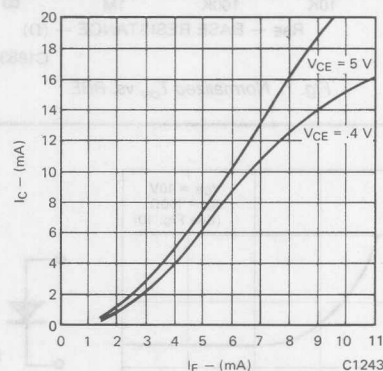


Fig. 4. Collector Current vs. Forward Current

C1243

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

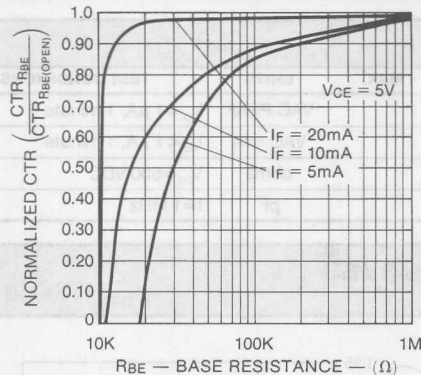


Fig. 5. CTR vs. RBE (Unsaturated)

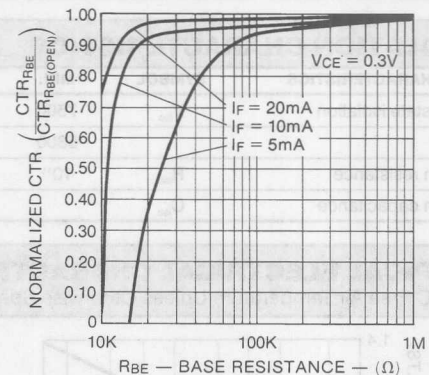


Fig. 6. CTR vs. RBE (Saturated)

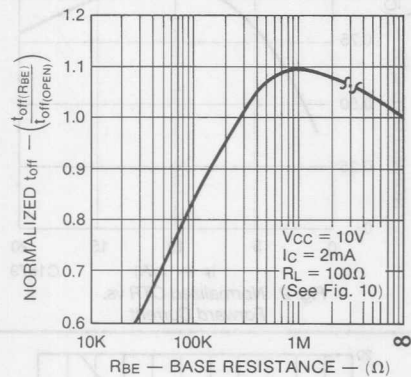


Fig. 7. Normalized T_{OFF} vs. RBE

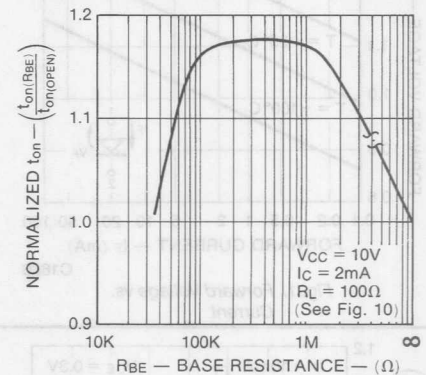


Fig. 8. Normalized T_{ON} vs. RBE

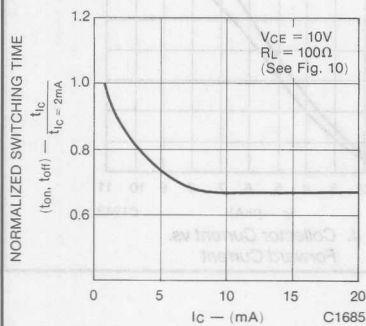


Fig. 9. Switching Time vs. I_C

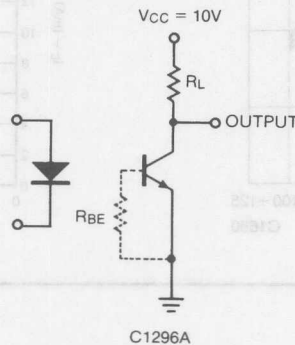


Fig. 10. Switching Time Test Circuit

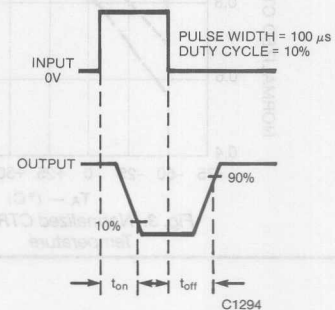
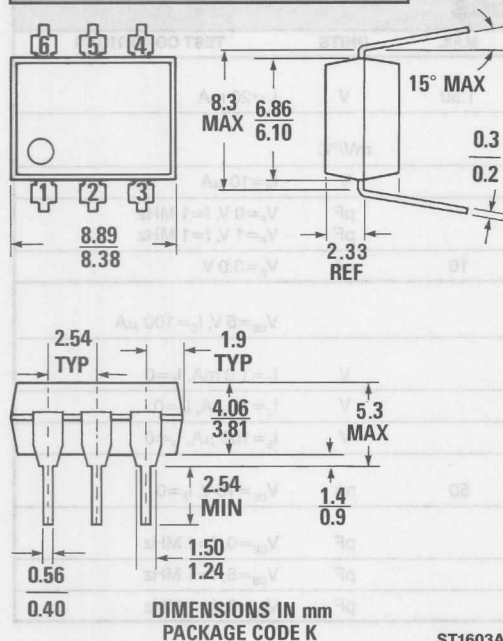


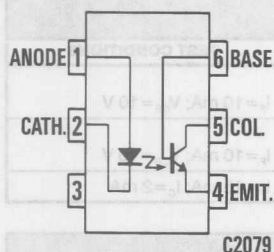
Fig. 11. Switching Time Waveforms

MCT271

PACKAGE DIMENSIONS



ST1603A



Equivalent Circuit

DESCRIPTION

The MCT271 is a phototransistor-type optically coupled isolator. A gallium arsenide infrared emitting diode is selectively coupled with an NPN silicon phototransistor.

FEATURES

- Controlled Current Transfer Ratio—45% to 90% (specified conditions)
- Maximum Turn-on-time—7 μ seconds (specified condition)
- Maximum Turn-off-time—7 μ seconds (specified condition)
- Underwriters Laboratory (U.L.) recognized—File E90700

APPLICATIONS

- Switching networks
- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.4 mW/°C

INPUT DIODE

Forward DC current	60 mA
Reverse voltage	3 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	90 mW
Derate linearly from 25°C	1.2 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)**INDIVIDUAL COMPONENT CHARACTERISTICS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.20	1.50	V	$I_F=20\text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	3.0	25		V	$I_R=10\text{ }\mu\text{A}$
Junction capacitance	C_J		50		pF	$V_F=0\text{ V}, f=1\text{ MHz}$
			65		pF	$V_F=1\text{ V}, f=1\text{ MHz}$
Reverse leakage current	I_R		0.35	10	μA	$V_R=3.0\text{ V}$
OUTPUT TRANSISTOR						
DC forward current gain	h_{FE}	100	420			$V_{CE}=5\text{ V}, I_C=100\text{ }\mu\text{A}$
Breakdown voltage						
Collector to emitter	BV_{CEO}	30	45		V	$I_C=1.0\text{ mA}, I_F=0$
Collector to base	BV_{CBO}	70	130		V	$I_C=10\text{ }\mu\text{A}, I_F=0$
Emitter to base	BV_{EBO}	5	7		V	$I_E=100\text{ }\mu\text{A}, I_F=0$
Leakage current						
Collector to emitter	I_{CEO}		5	50	nA	$V_{CE}=10\text{ V}, I_F=0$
Capacitance						
Collector to emitter			8		pF	$V_{CE}=0, f=1\text{ MHz}$
Collector to base			20		pF	$V_{CB}=5, f=1\text{ MHz}$
Emitter to base			10		pF	$V_{EB}=0, f=1\text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current transfer ratio, collector to emitter (a)	CTR_{CE}	45	67	90	%	$I_F=10\text{ mA}; V_{CE}=10\text{ V}$
Current transfer ratio, collector to base	CTR_{CB}		0.15		%	$I_F=10\text{ mA}; V_{CB}=10\text{ V}$
Saturation voltage	$V_{CE(SAT)}$		0.14	.40	V	$I_F=16\text{ mA}; I_C=2\text{ mA}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						
Turn-on time	t_{on}		4.9	7	μs	$R_L=100\Omega; I_C=2\text{ mA}; V_{CC}=5\text{ V}$
Turn-off time	t_{off}		4.5	7	μs	See Figs. 10, 11
Saturated						
Turn-on time	t_{on}		5.2		μs	$I_F=16\text{ mA}; R_L=1.9\text{ K}\Omega$
Turn-off time (Approximates a typical TTL interface)	t_{off}		38		μs	See Figs. 10, 11
Turn-on time	t_{on}		4.9		μs	$I_F=16\text{ mA}; R_L=4.7\text{ K}\Omega$
Turn-off time (Approximates a typical low power TTL interface)	t_{off}		90		μs	See Figs. 10, 11

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Temperature Unless Otherwise Specified) (Cont'd)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Steady state isolation	V_{iso}	7500			VAC-PEAK	$I_{L0} \leq 1 \mu A$
		5300			VAC-rms	1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{L0} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f = 1 \text{ MHz}$

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

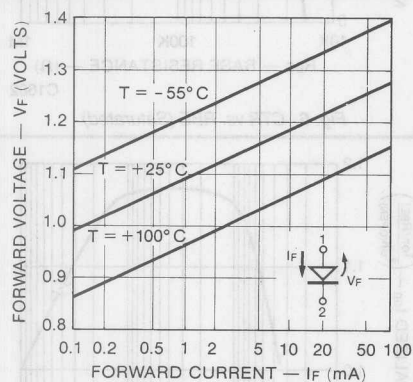


Fig. 1. Forward Voltage vs. Current

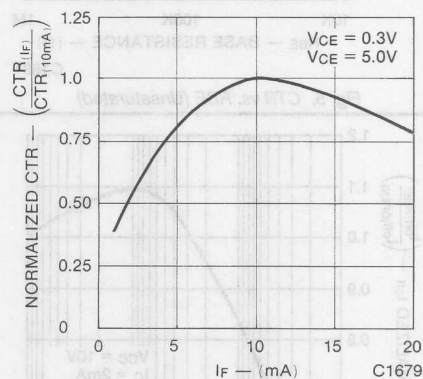


Fig. 2. Normalized CTR vs. Forward Current

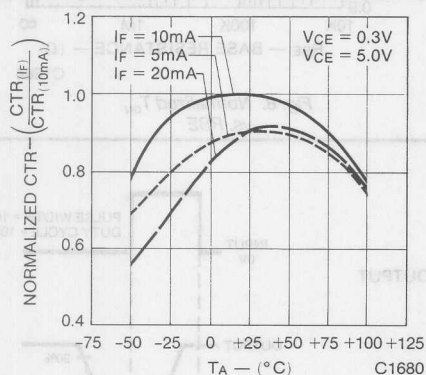


Fig. 3. Normalized CTR vs. Temperature

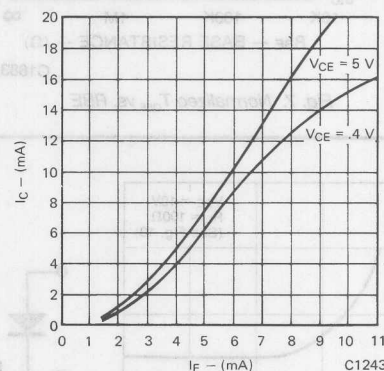


Fig. 4. Collector Current vs. Forward Current

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

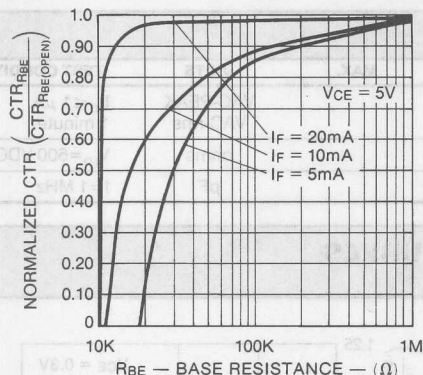


Fig. 5. CTR vs. RBE (Unsaturated)

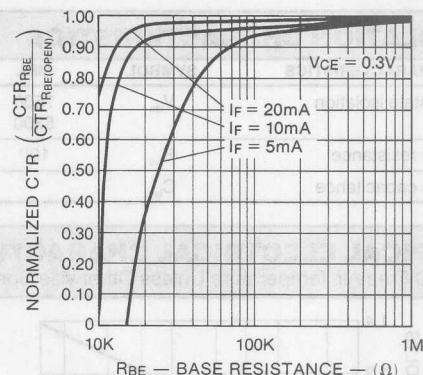


Fig. 6. CTR vs. RBE (Saturated)

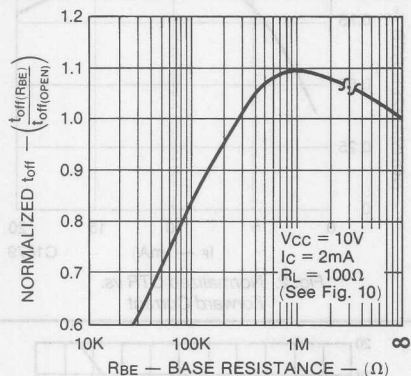


Fig. 7. Normalized T_{OFF} vs. RBE

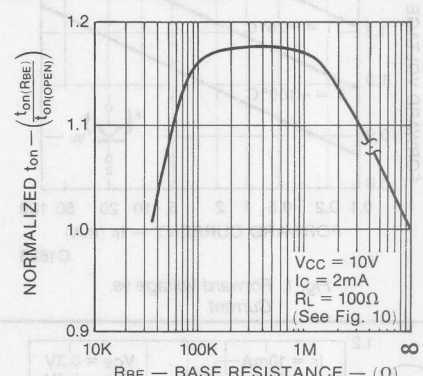


Fig. 8. Normalized T_{ON} vs. RBE

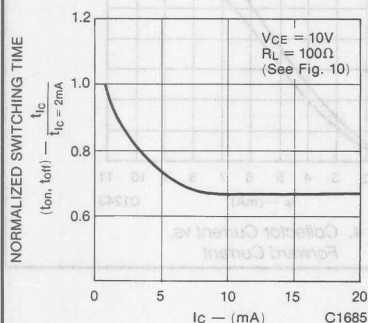


Fig. 9. Switching Time vs. I_C

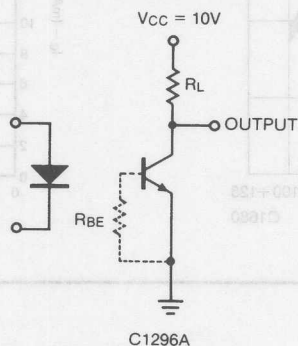


Fig. 10. Switching Time Test Circuit

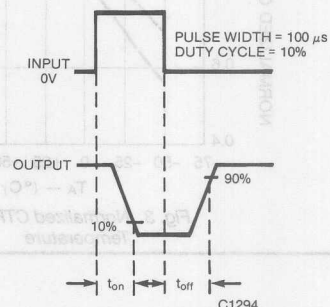
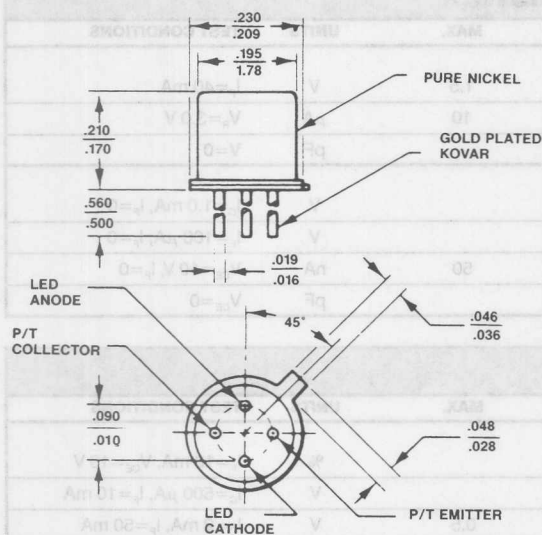


Fig. 11. Switching Time Waveforms

MCT4

PACKAGE DIMENSIONS



BOTTOM VIEW

C950

DIMENSIONS IN INCHES

DESCRIPTION

The MCT4 is a standard four-lead, TO-18 package containing a GaAs infrared emitting diode optically coupled to an NPN silicon planar phototransistor.

FEATURES

- Hermetic package
- High current transfer ratio; typically 35%
- High isolation resistance; 10^{11} ohms at 500 volts
- High voltage isolation emitter to detector

ABSOLUTE MAXIMUM RATINGS

Storage temperature	−65°C to 150°C
Operating temperature	−55°C to 125°C
Lead soldering temperature (10 sec)	260°C
LED (GaAs Diode)	
Power dissipation at 25°C ambient	90 mW
Derate linearly from 25°C	1.2 mW/°C
Continuous forward current	40 mA
Reverse voltage	3.0 V

Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Total power dissipation	250 mW
Derate linearly from 25°C	3.3 mW/°C
DETECTOR (Silicon phototransistor)	
Power dissipation at 25°C ambient	200 mW
Derate linearly from 25°C	2.67 mW/°C
Collector-emitter breakdown voltage (BV_{CE0})	30 V
Emitter-collector breakdown voltage (BV_{EC0})	7.0 V
ISOLATION VOLTAGE	1000 VDC

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
EMITTER					
Forward voltage		1.3	1.5	V	$I_F = 40 \text{ mA}$
Reverse current		.15	10	μA	$V_R = 3.0 \text{ V}$
Capacitance		150		pF	$V = 0$
DETECTOR					
BV_{CEO}	30			V	$I_C = 1.0 \text{ mA}, I_F = 0$
BV_{ECO}	7	12		V	$I_E = 100 \mu\text{A}, I_F = 0$
I_{CEO} (Dark)		5	50	nA	$V_{CE} = 10 \text{ V}, I_F = 0$
Capacitance collector-emitter		2		pF	$V_{CE} = 0$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
COUPLED					
DC current transfer ratio	15	35		%	$I_F = 10 \text{ mA}, V_{CE} = 10 \text{ V}$
$V_{CE(SAT)}$		0.1		V	$I_C = 500 \mu\text{A}, I_F = 10 \text{ mA}$
		0.2	0.5	V	$I_C = 2 \text{ mA}, I_F = 50 \text{ mA}$

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Capacitance LED to detector		1.8		pF	
Bandwidth (see figure 5)		300		kHz	Note 2
Rise time and fall time (see operating schematic)		2		μs	$I_C = 2 \text{ mA}, V_{CE} = 10 \text{ V}$ Note 3

ISOLATION CHARACTERISTICS

CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Breakdown voltage	1000	1500		VDC	$t = 1 \text{ second}$
Resistance emitter-detector	10^{11}	10^{12}		ohms	$V = 500 \text{ VDC}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

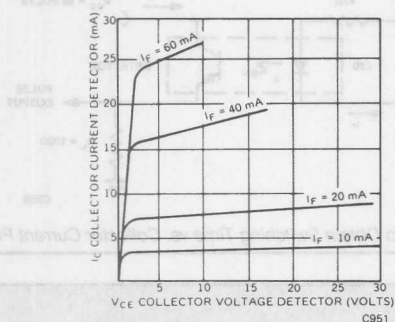


Fig. 1. Detector Output Characteristics

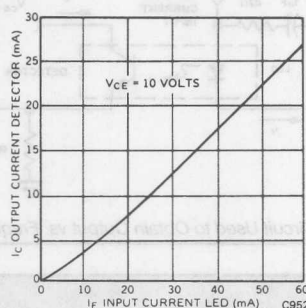


Fig. 2. Input Current vs. Output Current

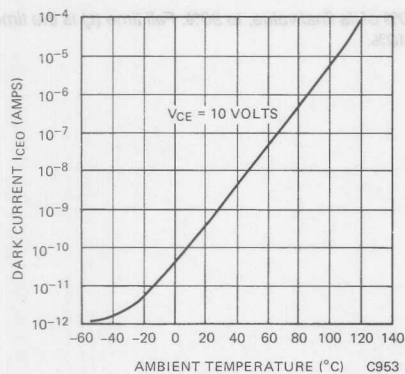


Fig. 3. Dark Current vs. Temperature (°C)

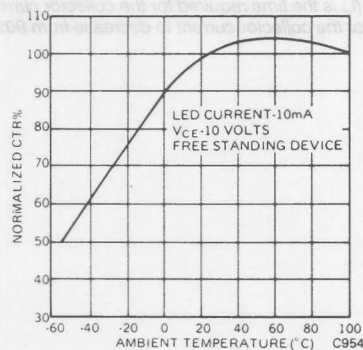


Fig. 4. Current Output vs. Temperature

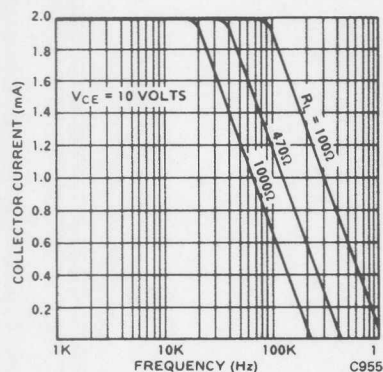


Fig. 5. Output vs. Frequency

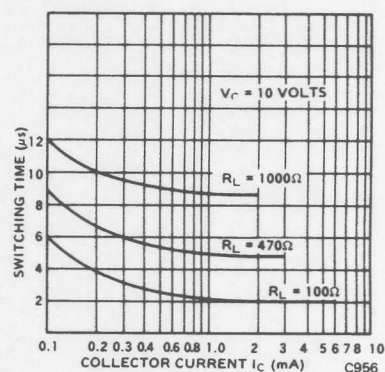
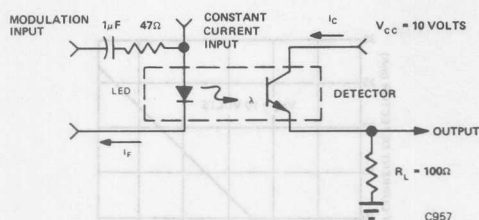


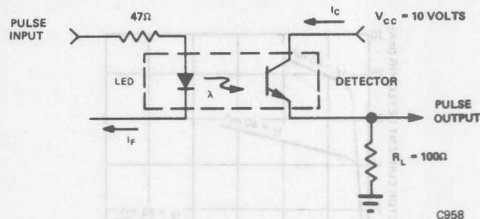
Fig. 6. Switching Time vs. Collector Current

For additional characteristic curves, see MCT2

OPERATING SCHEMATICS



Modulation Circuit Used to Obtain Output vs. Frequency Plot



Circuit Used to Obtain Switching Time vs. Collector Current Plot

NOTES

1. The current transfer ratio (I_c/I_f) is the ratio of the detector collector current to the LED input current with V_{ce} at 10 volts.
2. The frequency at which i_c is 3 dB down from the 1 kHz value.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

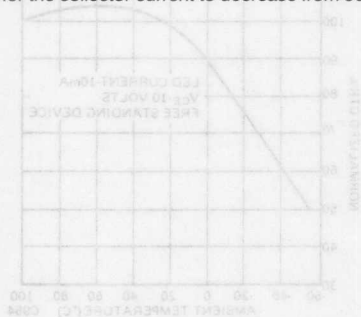


Fig. 4. Current Output vs. Temperature

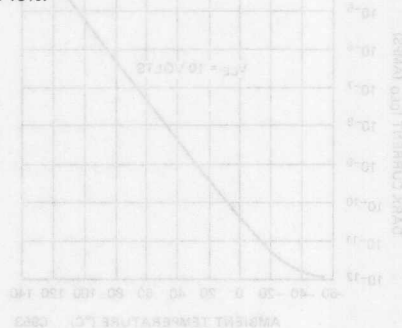


Fig. 5. Dark Current vs. Temperature

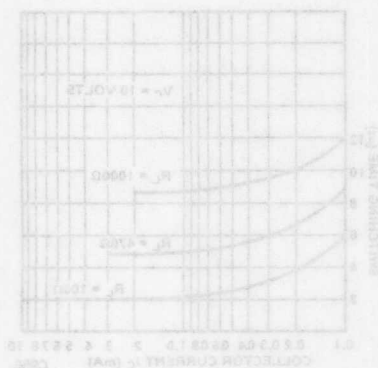


Fig. 6. Switching Time vs. Collector Current

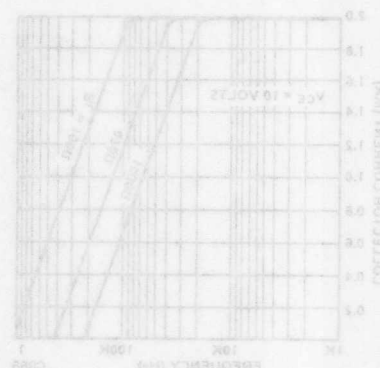
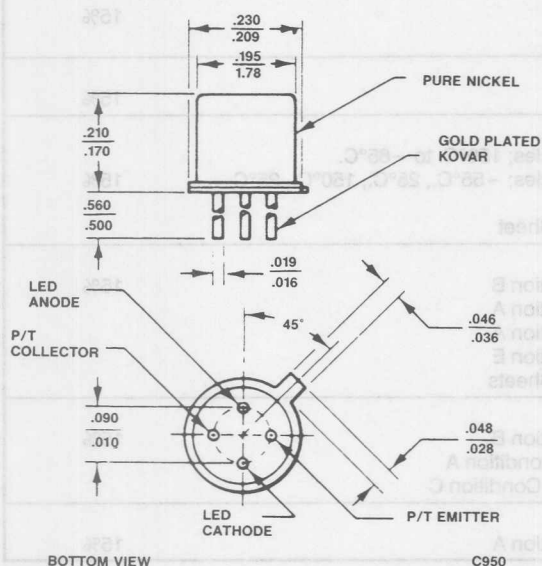


Fig. 7. Output vs. Frequency

For additional characteristic curves, see MCT5.

MCT4R

PACKAGE DIMENSIONS



BOTTOM VIEW

C950

DIMENSIONS IN INCHES

DESCRIPTION

The MCT4R is a standard four-lead, TO-18 package containing a GaAs infrared emitting diode optically coupled to a silicon planar phototransistor.

FEATURES

- Hermetic package
- High current transfer ratio; typically 35%
- High isolation resistance, 10¹¹ ohms at 500 volts
- High voltage isolation emitter to detector
- Screened to MIL-STD-883 Class B

APPLICATIONS

The MCT4R is designed and manufactured to conform to the requirements of military systems. Reliability testing has proven the product capable of conforming to the screening and quality conformance requirements of MIL-STD-883C Class B devices.

SCREEN—100%		
Characteristic	Method	
Internal Visual	2010	Characteristics applicable to device
Stabilization Bake	1008	150°C. for 48 hours
Temperature Cycle	1010	10 cycles; -55°C., 25°C., 150°C., 25°C.
Centrifuge	2001	Test Condition E
Hermeticity	1014	Fine and Gross
Critical Electrical	—	Data Sheet
Burn In	1015	160 hours @ 125°C
Final Electrical	—	Data Sheet
Group A Sample Inspection	5005	Table I Subgroups
External Visual	2009	

LOT QUALIFICATION TESTS

CHARACTERISTIC	METHOD	LTPD
Subgroup I		
Visual Mechanical		
Marking Permanency	2008	15%
Physical Dimensions		
Subgroup II		
Solderability	2003	15%
Subgroup III		
Thermal Shock	1011 — 15 cycles; 150°C. to -65°C.	
Temperature Cycle	1010 — 10 cycles; -55°C., 25°C., 150°C., 25°C.	15%
Moisture Resistance	1004	
Critical Electrical	— Data Sheet	
Subgroup IV		
Mechanical Shock	2002 — Condition B	15%
Vibration Fatigue	2005 — Condition A	
Vibration Variable Frequency	2007 — Condition A	
Constant Acceleration	2001 — Condition E	
Critical Electrical	— Data Sheets	
Subgroup V		
Lead Fatigue	2004 — Condition B ₂	15%
Hermeticity	1014 — Fine Condition A Gross Condition C	
Subgroup VI		
Salt Atmosphere	1009 — Condition A	15%

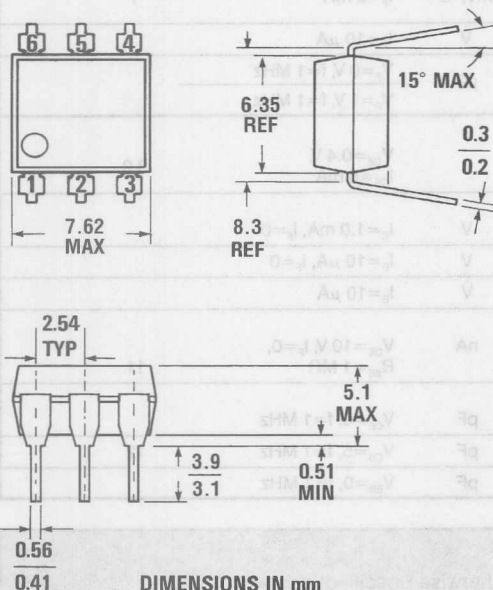
LIFE TESTING 7% LTPD

CHARACTERISTIC	METHOD	LTPD
Subgroup VII		
High Temperature Storage	1008 — 150°C. for 1000 hours	7%
Critical Electrical	— Data Sheet	
Subgroup VIII		
Operating Life	1005 — Condition B	7%
Critical Electrical	— Data Sheets	
Subgroup IX		
Steady State Reverse Bias	1015 — Condition A; 72 hours at 150°C.	7%
Subgroup X		
Bond Strength	2001 — Condition C; 10 devices only	

Reference: MIL-STD-883C Test Methods and Procedures for Microelectronics.

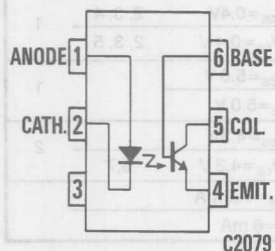
**MCT5200
MCT5201**

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE E

ST1603-01



Equivalent Circuit

DESCRIPTION

The MCT520X are high performance logic compatible phototransistor type optically coupled isolator products. They are constructed using a very low degradation and high-efficiency AlGaAs, 890 nm infrared emitter, coupled to a high speed NPN phototransistor, in a six-pin dual in-line package. They provide a very high current transfer ratio (CTR), high switching speed and 5300 VAC RMS withstand test voltage performance. The critical circuit design parameters of CTR_{CE} and CTR_{CB} are guaranteed over a temperature range of 0-70°C resulting in guaranteed switching propagation delays when interfaced to LSTTL logic.

The MCT5201 has a minimum saturated CTR of 120% for a LED input current of 5 mA. Maximum LSTTL interface propagation delays of 30 μ s are guaranteed with the use of an external 330K resistor between the base and emitter. The MCT5200 is specified for a minimum saturated CTR of 75% for an input current of 10 mA.

FEATURES

- High $CTR_{CE(SAT)}$ comparable to Darlington
- Guaranteed switching speed with LSTTL load
- Performance guaranteed over 0°C to 70°C
- High common mode rejection—5 kV/ μ s
- Data rates up to 150 kbits/s (NRZ)
- Underwriters Laboratory (UL) recognized file #E90700

APPLICATIONS

- LSTTL digital logic isolation
- IEEE 488 isolated inputs
- Switching power supply
- High speed industrial interfaces
- Isolated microprocessor inputs

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	—55°C to 150°C
Operating temperature	—55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package, power dissipation (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	40 mA
Reverse voltage	6 V
Peak forward current (1 μ s pulse, 300 pps)	1.0 A
Power dissipation	54 mW
Derate linearly from 25°C	0.7 mW/°C

OUTPUT TRANSISTOR

Power dissipation	200 mW
Derate linearly from 25°C	2.67 mW/°C

INDIVIDUAL COMPONENT CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
INPUT DIODE								
Forward voltage	V_F		1.3	1.5	V	$I_F=5\text{ mA}$	1	
Forward voltage coefficient	$\Delta V_F/\Delta T_A$		-1.9		mV/ $^\circ\text{C}$	$I_F=2\text{ mA}$	1	
Reverse voltage	V_R	6			V	$I_R=10\text{ }\mu\text{A}$		
Junction capacitance	C_J		18		pF	$V_F=0\text{ V}, f=1\text{ MHz}$ $V_F=1\text{ V}, f=1\text{ MHz}$		
OUTPUT TRANSISTOR								
DC forward current gain	$h_{FE(\text{SAT})}$		400	—		$V_{CE}=0.4\text{ V}$, $I_{CE}=6\text{ mA}$	8,9	
Breakdown voltage								
Collector to emitter	BV_{CEO}	30	45		V	$I_C=1.0\text{ mA}, I_F=0$		
Collector to base	BV_{CBO}	30	70		V	$I_C=10\text{ }\mu\text{A}, I_F=0$		
Emitter to base	BV_{EBO}	5	7		V	$I_E=10\text{ }\mu\text{A}$		
Leakage								
Collector to emitter	I_{CER}		5	100	nA	$V_{CE}=10\text{ V}, I_F=0$, $R_{BE}=1\text{ M}\Omega$	11	
Capacitance								
Collector to emitter	C		8		pF	$V_{CE}=0, f=1\text{ MHz}$		
Collector to base			20		pF	$V_{CB}=5, f=1\text{ MHz}$	12	
Emitter to base			7		pF	$V_{EB}=0, f=1\text{ MHz}$		

TRANSFER CHARACTERISTICS

(Over Recommended Temperature, $T_A=0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

DC CHARACTERISTICS	SYMBOL	DEVICE	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Saturated current transfer ratio (collector to emitter)	$CTR_{CE(\text{SAT})}$	MCT5200	75	150		%	$I_F=10\text{ mA}, V_{CE}=0.4\text{ V}$	2, 3, 4	1
		MCT5201	120	225		%	$I_F=5.0\text{ mA}, V_{CE}=0.4\text{ V}$	2, 3, 5	
Current transfer ratio (collector to emitter)	CTR_{CE}	MCT5200		200		%	$I_F=10\text{ mA}, V_{CE}=5.0\text{ V}$		1
		MCT5201		300		%	$I_F=5\text{ mA}, V_{CE}=5.0\text{ V}$		
Current transfer ratio (collector to base)	CTR_{CB}	MCT5200	0.2	0.3		%	$I_F=10\text{ mA}, V_{CB}=4.3\text{ V}$		2
		MCT5201	0.28	0.5		%	$I_F=5.0\text{ mA}, V_{CB}=4.3\text{ V}$	6, 7	
Saturation voltage (collector to emitter)	$V_{CE(\text{SAT})}$	MCT5200		0.2	0.4	V	$I_F=10\text{ mA}, I_{CE}=7.5\text{ mA}$		
		MCT5201		0.2	0.4	V	$I_F=5\text{ mA}, I_{CE}=6\text{ mA}$		

*All typicals $T_A=25^\circ\text{C}$

SWITCHING CHARACTERISTICS

(Over Recommended Temperature, $T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.*	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
MCT-5200								
Delay time	t_d		3	7	μs	$I_F = 10\text{ mA}$, $V_{CE} = 0.4\text{ V}$ $R_L = 1.0\text{ K}$, $R_{BE} = 330\text{ K}$ $V_{CC} = 5.0\text{ V}$	15,18	3,4 5,6
Rise time	t_r		2	6	μs			
Storage time	t_s		12	18	μs			
Fall time	t_f		17	30	μs			
Propagation delay H→L	t_{PHL}	μs	5	12	μs	$I_F = 10\text{ mA}$, $V_{CE} = 0.4\text{ V}$ $V_{CC} = 5.0\text{ V}$, $R_L = (\text{Fig. 18})$ $R_{BE} = 330\text{ K}$		7
Propagation delay L→H	t_{PLH}	μs	13	20	μs			
MCT-5201								
Delay time	t_d		7	15	μs	$I_F = 5\text{ mA}$, $V_{CE} = 0.4\text{ V}$ $R_L = 1.0\text{ K}$, $R_{BE} = 330\text{ K}$ $V_{CC} = 5.0\text{ V}$	13,18	3,4 5,6
Rise time	t_r		6	20	μs			
Storage time	t_s		8	13	μs			
Fall time	t_f		19	30	μs			
Propagation delay H→L	t_{PHL}		12	30	μs	$I_F = 5\text{ mA}$, $V_{CE} = 0.4\text{ V}$ $V_{CC} = 5.0\text{ V}$, $R_L = (\text{Fig. 18})$ $R_{BE} = 330\text{ K}$		7
Propagation delay L→H	t_{PLH}		8	13	μs			

*All typicals $T_A = 25^\circ\text{C}$

ISOLATION CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	FIG.	NOTE
Common mode rejection—output high	CM_H		5000		$\text{V}/\mu\text{s}$	$V_{CM} = 50\text{ V}_{p-p}$ $R_L = 1\text{ K}\Omega$, $I_F = 0$	17	
Common mode rejection—output low	CM_L		5000		$\text{V}/\mu\text{s}$	$V_{CM} = 50\text{ V}_{p-p}$ $R_L = 1\text{ K}\Omega$, $I_F = 5\text{ mA}$		
Common mode coupling capacitor	C_{cm}		0.2		pF		8	
Package capacitance input/output	C_{i-o}		0.7		pF	$V_{i-o} = 0$, $f = 1\text{ MHz}$	9	
Withstand insulation test voltage	V_{ISO}	5300			$V_{AC(RMS)}$	$I_{i-o} \leq 1\text{ }\mu\text{A}$, 1 minute	10	8
	V_{ISO}	7500			$V_{AC(Peak)}$	$I_{i-o} \leq 1\text{ }\mu\text{A}$, 1 minute	10	8
Insulation resistance	R_{ISO}	10^{11}			Ohms	$V_{i-o} = 500\text{ V}$		

NOTES

- DC current transfer ratio (CTR_{CE}) is defined as the transistor collector current (I_{CE}) divided by input LED current (I_F) $\times 100\%$, at a specified voltage collector to emitter (V_{CE}).
- Current transfer ratio is defined as the collector to base photocurrent (I_{CB}) divided by the input LED current (I_F) times 100%.
- Switching delay time (t_d) is measured for 50% of LED current to 90% falling edge of V_o .
- Rise time (t_r) is measured from the 90% to 10% of V_o falling edge.
- Storage time (t_s) is measured from 50% of falling edge of LED current to 10% of rise edge of V_o .
- Fall time (t_f) is measured from the 10% to 90% of the rising edge of V_o .
- The t_{PLH} propagation delay is measured from 50% point on the falling edge of the input pulse to the 1.3 V point on the rising edge of the output pulse. The t_{PHL} propagation delay is measured from 50% point on the rising edge of input to 1.3 V point on falling edge of output pulse.
- Device considered a two terminal device: Pins 1, 2, and 3 are shorted together. Pins 4, 5, and 6 are shorted together.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

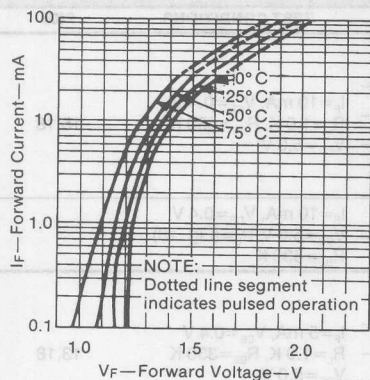


Fig. 1. Forward Voltage vs. Forward Current

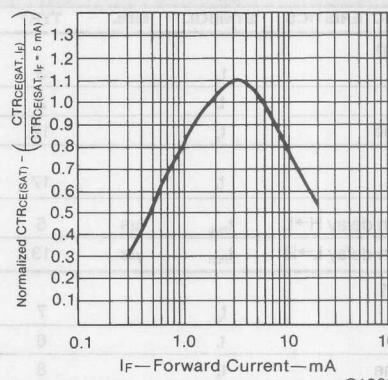


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

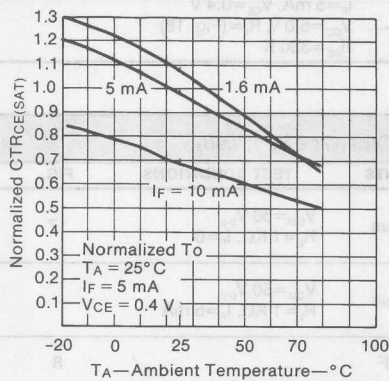


Fig. 3. Normalized CTR vs. Temperature

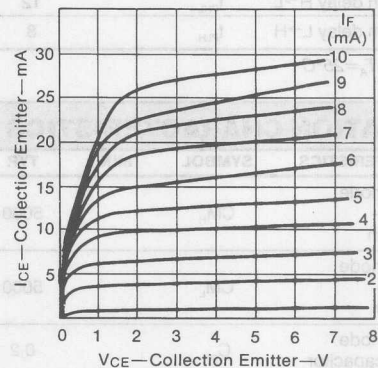


Fig. 4. MCT5200 Collector Current vs. Collector to Emitter Voltage

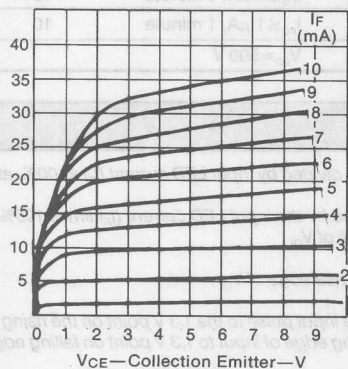


Fig. 5. MCT5201 Collector Current vs. Collector to Emitter Voltage

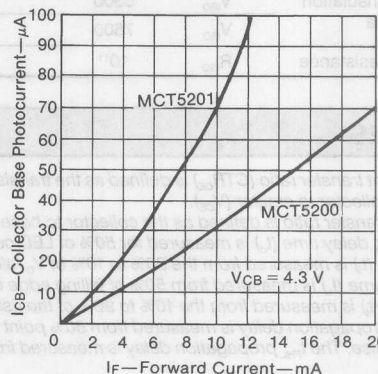


Fig. 6. Collector Base Photocurrent vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

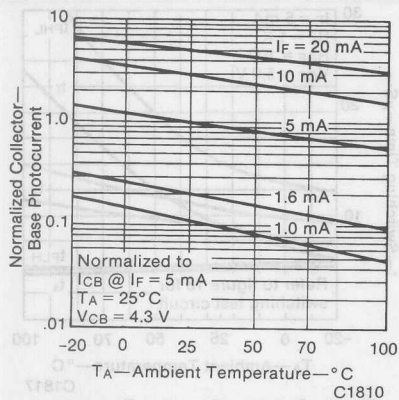


Fig. 7. Normalized Collector Base Photocurrent vs. Ambient Temperature

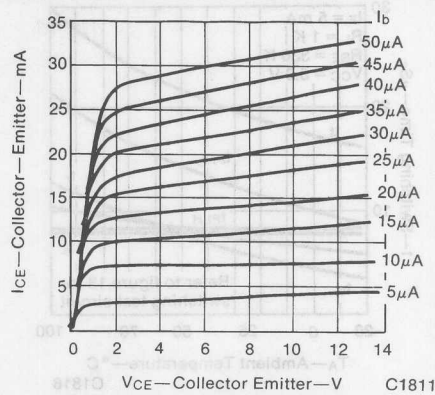


Fig. 8. Collector Current vs. Collector to Emitter Voltage

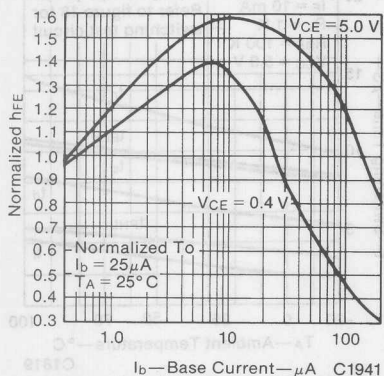


Fig. 9. Normalized h_{FE} vs. Base Current

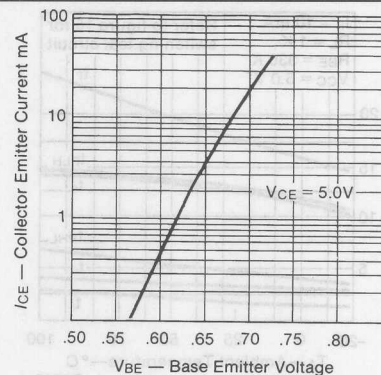


Fig. 10. Collector Current (I_{CE}) vs. Base Emitter Voltage (V_{BE})

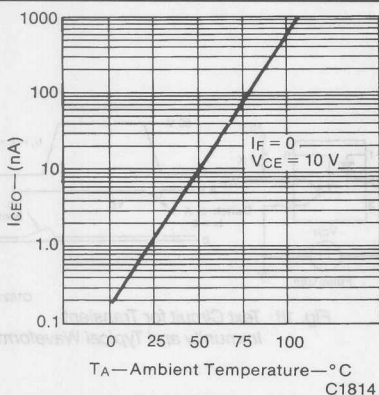


Fig. 11. Collector to Emitter Leakage Current vs. Temperature

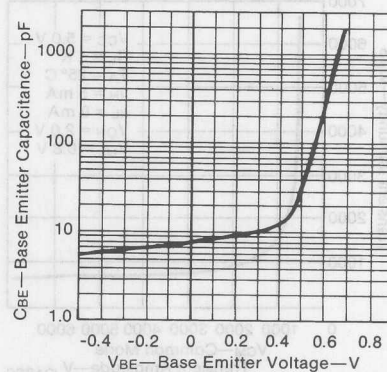


Fig. 12. Base Emitter Capacitance vs. Base Emitter Voltage

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

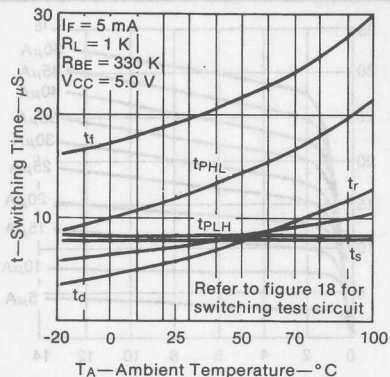


Fig. 13. Switching Time vs. Temperature
 $I_F = 5 \text{ mA}$ $R_{BE} = 330 \text{ K}$

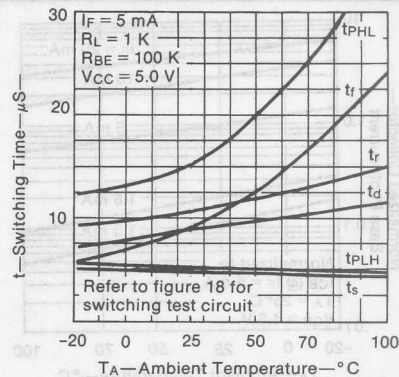


Fig. 14. Switching Speed vs. Temperature
 $I_F = 5 \text{ mA}$ $R_{BE} = 100 \text{ K}$

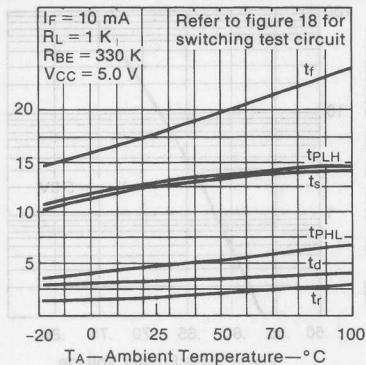


Fig. 15. Switching Speed vs. Temperature
 $I_F = 5 \text{ mA}$ $R_{BE} = 330 \text{ K}$

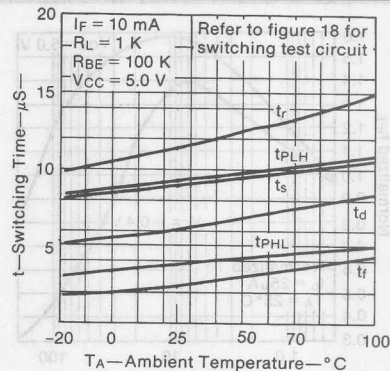


Fig. 16. Switching Speed vs. Temperature
 $I_F = 5 \text{ mA}$ $R_{BE} = 100 \text{ K}$

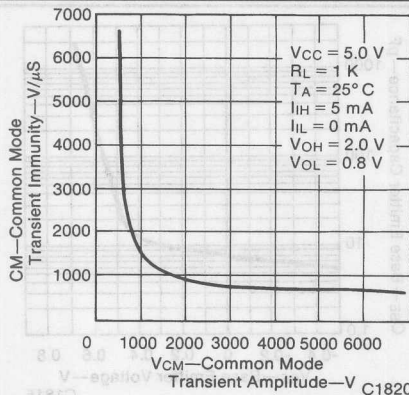


Fig. 17. Common Mode Transient Rejection vs. Common Mode Transient Voltage

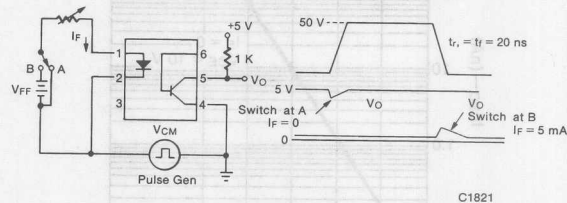
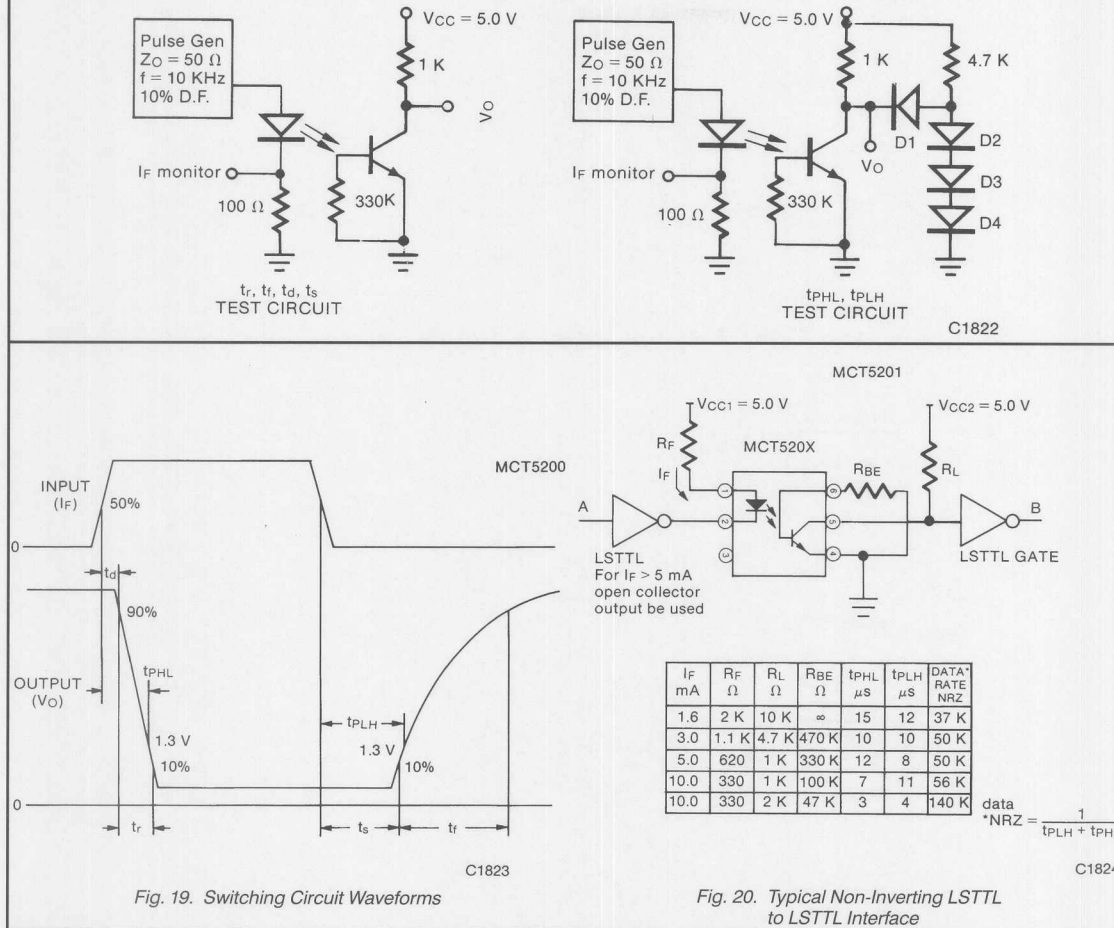


Fig. 18. Text Circuit for Transient Immunity and Typical Waveforms

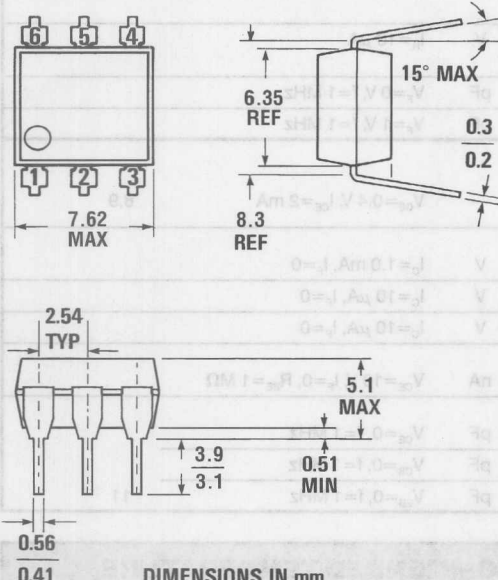
TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)



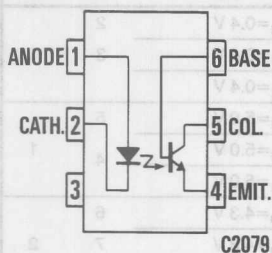
**MCT5210
MCT5211**

PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**

ST1603-01



Equivalent Circuit

DESCRIPTION

The MCT-521X are high performance CMOS/LSTTL logic compatible phototransistor type optically coupled isolator products. They are constructed using a very low degradation and high-efficiency AlGaAs, infrared emitter, coupled to a photoefficient high gain NPN phototransistor in a six pin dual-in-line package. This package provides a minimum of 5300 VAC Withstand Test Insulation, and 5000 V/ μ s common mode transient rejection.

The MCT-5211 is well suited for CMOS to LSTTL/TTL interfaces, for it offers 250% CTR_{CE(SAT)} with 1 mA of LED input current. When an LED input current of 1.6 mA is supplied data rates to 20K bits/s are possible.

The MCT-5210 can easily interface LSTTL to LSTTL/TTL, and with use of an external base to emitter resistor data rates of 100 K bits/s can be achieved.

FEATURES

- High CTR_{CE(SAT)} comparable to Darlington
- CTR guaranteed 0°C to 70°C
- High common mode transient rejection—5 kV/ μ s
- Data rates up to 50 kbits/s (NRZ)
- Underwriters Laboratory (UL) recognized file #E90700

APPLICATIONS

- CMOS to CMOS/LSTTL logic isolation
- LSTTL to CMOS/LSTTL logic isolation
- RS-232 line receiver
- Telephone ring detector
- AC line voltage sensing

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec.)	260°C
Total package power dissipation at 25°C	
(LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	40 mA
Reverse voltage	6 V
Peak forward current (1 μ s pulse, 300 pps)	1.0 A
Power dissipation	54 mW
Derate linearly from 25°C	0.7 mW/°C

OUTPUT TRANSISTOR

Power dissipation	200 mW
Derate linearly from 25°C	2.67 mW/°C

INDIVIDUAL COMPONENT CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTE
INPUT DIODE								
Forward voltage	V_F		1.3	1.5	V	$I_F=5\text{ mA}$	1	
Forward voltage coefficient	$\Delta V_F/\Delta T_A$		-1.9		mV/°C	$I_F=2\text{ mA}$	1	
Reverse voltage	V_R	5			V	$I_R=10\text{ }\mu\text{A}$		
Junction capacitance	C_J		18		pF	$V_F=0\text{ V}, f=1\text{ MHz}$		
			112		pF	$V_F=1\text{ V}, f=1\text{ MHz}$		
OUTPUT TRANSISTOR								
DC forward current gain	$h_{FE(SAT)}$		350		—	$V_{CE}=0.4\text{ V}, I_{CE}=2\text{ mA}$	8,9	
Breakdown voltage Collector to emitter	BV_{CEO}	30	45		V	$I_C=1.0\text{ mA}, I_F=0$		
Collector to base	BV_{CBO}	30	70		V	$I_C=10\text{ }\mu\text{A}, I_F=0$		
Emitter to base	BV_{EBO}	5	7		V	$I_C=10\text{ }\mu\text{A}, I_F=0$		
Leakage current Collector to emitter	I_{CER}			100	nA	$V_{CE}=10\text{ V}, I_F=0, R_{BE}=1\text{ M}\Omega$		
Capacitance Collector to emitter	C		10		pF	$V_{CE}=0, f=1\text{ MHz}$		
Collector to base			80		pF	$V_{CB}=0, f=1\text{ MHz}$		
Emitter to base			15		pF	$V_{EB}=0, f=1\text{ MHz}$	11	

TRANSFER CHARACTERISTICS OVER RECOMMENDED TEMPERATURE

($T_A = 0^\circ\text{C}$ to 70°C Unless Otherwise Specified)

CHARACTERISTICS	SYMBOL	DEVICE	MIN	TYP*	MAX	UNITS	TEST CONDITIONS	FIG.	NOTE
Saturated current		MCT5210	60	350		%	$I_F = 3.0\text{ mA}, V_{CE} = 0.4\text{ V}$	2	
Transfer ratio (Collector to emitter)	$CTR_{CE\text{ SAT}}$	MCT5211	100	300		%	$I_F = 1.6\text{ mA}, V_{CE} = 0.4\text{ V}$	3	
			75	250		%	$I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V}$		
Current transfer ratio (Collector to emitter)	CTR_{CE}	MCT5210	70	400		%	$I_F = 3.0\text{ mA}, V_{CE} = 5.0\text{ V}$	5	
		MCT5211	150	350		%	$I_F = 1.6\text{ mA}, V_{CE} = 5.0\text{ V}$	4	1
			110	300		%	$I_F = 1.0\text{ mA}, V_{CE} = 5.0\text{ V}$		
Current transfer ratio (Collector to base)	CTR_{CB}	MCT5210	0.2	0.9		%	$I_F = 3.0\text{ mA}, V_{CB} = 4.3\text{ V}$	6	
		MCT5211	0.3	0.75		%	$I_F = 1.6\text{ mA}, V_{CB} = 4.3\text{ V}$	7	2
			0.25	0.6		%	$I_F = 1.0\text{ mA}, V_{CB} = 4.3\text{ V}$		
Saturation voltage (Collector to emitter)	$V_{CE\text{ SAT}}$	MCT5210		0.2	0.4	V	$I_F = 3.0\text{ mA}, I_{CE} = 1.8\text{ mA}$		
		MCT5211		0.2	0.4	V	$I_F = 1.6\text{ mA}, I_{CE} = 1.6\text{ mA}$		

*All typicals $T_A = 25^\circ\text{C}$

SWITCHING CHARACTERISTICS (T _A =25°C Unless Otherwise Specified)								
CHARACTERISTICS	SYMBOL	DEVICE	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG. NOTE
Propagation delay H-L	t _{PHL}	MCT-5210	10			μs	R _L =330 Ω, R _{BE} =∞ I _F =3.0 mA	12 3
			12			μs	R _L =3.3 K, R _{BE} =39 K V _{CC} =5.0 V	
		MCT-5211	20			μs	R _L =750 Ω, R _{BE} =∞ I _F =1.6 mA	
			25			μs	R _L =4.7 K, R _{BE} =91 K V _{CC} =5.0 V	
			40			μs	R _L =1.5 K, R _{BE} =∞ I _F =1.0 mA	
			45			μs	R _L =10 K, R _{BE} =160 K V _{CC} =5.0 V	
Propagation delay L-H	t _{PLH}	MCT-5210	10			μs	R _L =330 Ω, R _{BE} =∞ I _F =3.0 mA	12 4
			12			μs	R _L =3.3 K, R _{BE} =39 K V _{CC} =5.0 V	
		MCT-5211	20			μs	R _L =750 Ω, R _{BE} =∞ I _F =1.6 mA	
			25			μs	R _L =4.7 K, R _{BE} =91 K V _{CC} =5.0 V	
			40			μs	R _L =1.5 K, R _{BE} =∞ I _F =1.0 mA	
			45			μs	R _L =10 K, R _{BE} =160 K V _{CC} =5.0 V	

ISOLATION CHARACTERISTICS (T _A =0°C Unless Otherwise Specified)								
CHARACTERISTICS	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS	FIG.	NOTE
Common mode transient Rejection - output high	CM _H		5000		V/μs	V _{CM} =50 V _{p-p} , R _L =750 Ω I _F =0	14	
Common mode transient Rejection - output low	CM _L		5000		V/μs	V _{CM} =50 I _{p-p} , R _L =750 Ω I _F =1.6 mA		
Common mode coupling capacitor	C _{CM}		0.2		pF		14	5
Package capacitance input/output	C _{I-O}		0.7		pF	V _{I-O} =0, f=1 MHz		6
Withstand insulation test voltage	V _{ISO}	5300			V _{AC(RMS)}	I _{I-O} ≤1 μA, 1 minute		7
	V _{ISO}	7500			V _{AC(Peak)}			
Insulation resistance	R _{ISO}	10 ¹¹			Ohms	V _{I-O} =500 V		

NOTES

1. DC Current Transfer Ratio (CTR_{CE}) is defined as the transistor collector current (I_{CE}) divided by the input LED current (I_F) x 100%, at a specified voltage between the collector and emitter (V_{CE}).
2. The collector base Current Transfer Ratio (CTR_{CB}) is defined as the collector base photocurrent (I_{CB}) divided by the input LED current (I_F) time 100%.
3. Referring to Figure 13 the t_{PHL} propagation delay is measured from the rising edge of the data input (A) to the rising edge of the rising edge of the data output (B).
4. Referring to Figure 13 the t_{PLH} propagation delay is measured from the falling edge of data input (A) to the falling edge of the data output (B).
5. C_{CM} is the capacitance between the LED (input assembly) to the base of the phototransistor.
6. C_{I-O} is the capacitance between the input (pins 1, 2, 3 connected) and the output, (pins 4, 5, 6 connected).
7. Device considered a two terminal device: Pins 1, 2, and 3 shorted together, and pins 5, 6, and 7 are shorted together.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

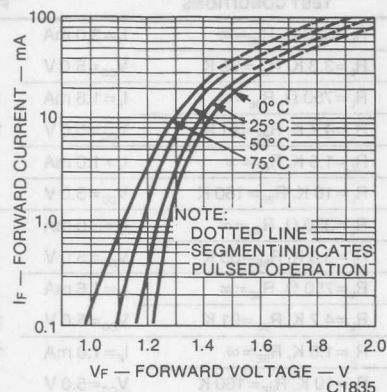


Fig. 1. Forward Voltage vs. Forward Current

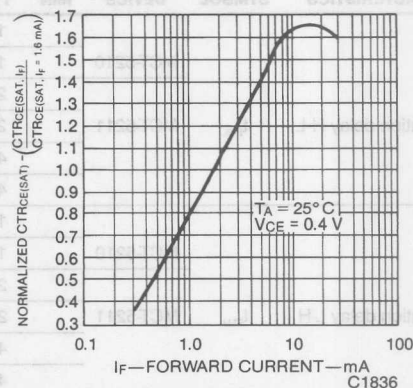


Fig. 2. Normalized Current Transfer Ratio vs. Forward Current

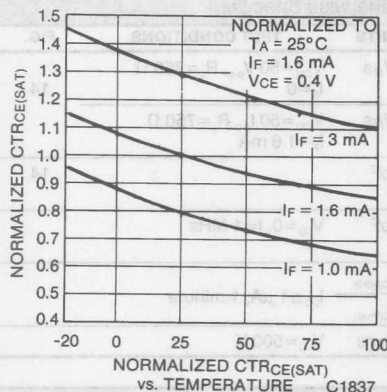


Fig. 3. Normalized CTR vs. Temperature

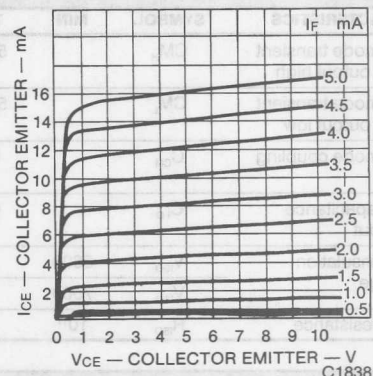


Fig. 4. DC Characteristics MCT5210

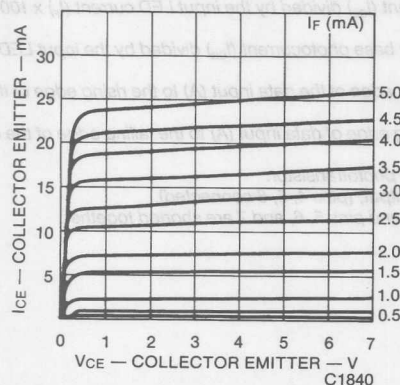


Fig. 5. DC Characteristics MCT5211

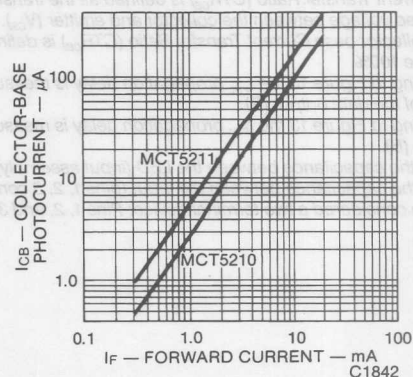


Fig. 6. Collector Base Photocurrent vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

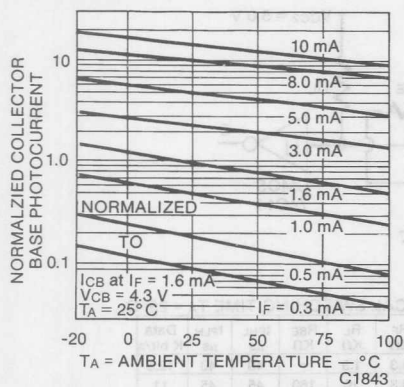


Fig. 7. Normalized Collector Base Photocurrent vs. Temperature

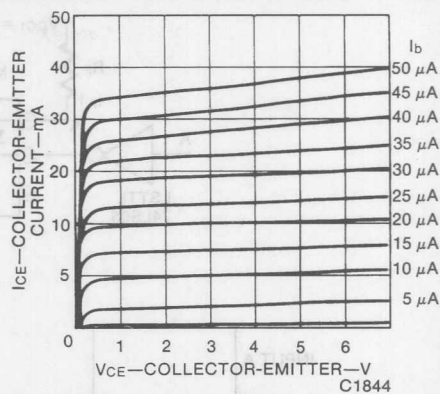


Fig. 8. Transistor DC Characteristics

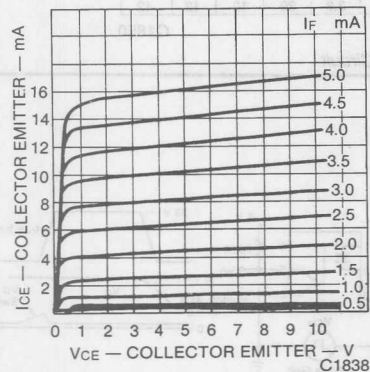


Fig. 9. $h_{FE(SAT)}$ vs. I_b vs. Temperature

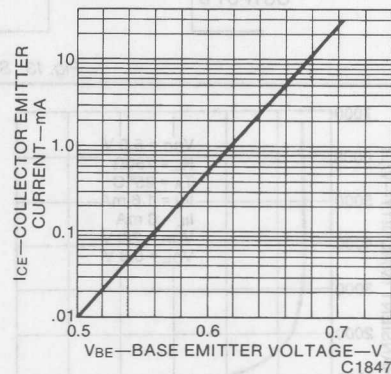


Fig. 10. Collector Current vs. Base Emitter Voltage

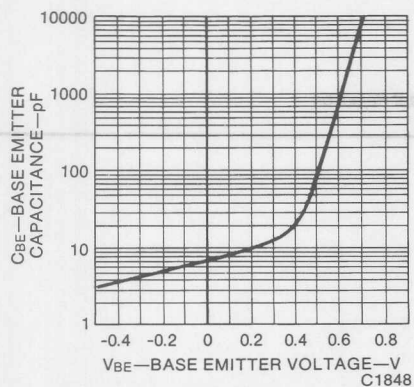


Fig. 11. C_{BE} vs. V_{BE}

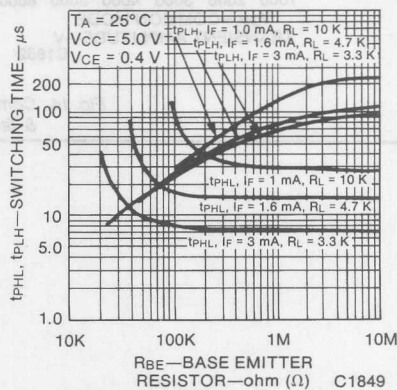


Fig. 12. Switching Time vs. R_{BE}

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (Cont'd)

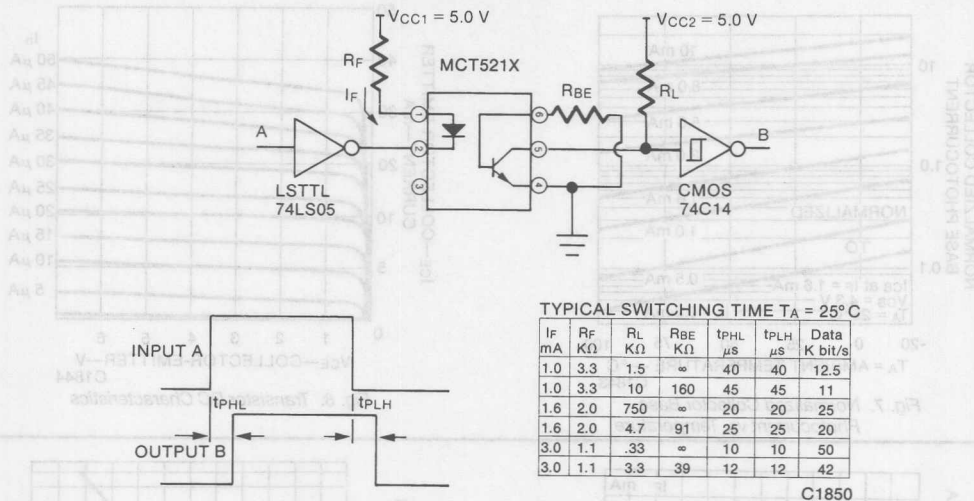


Fig. 13. Switching Speed Test Circuit

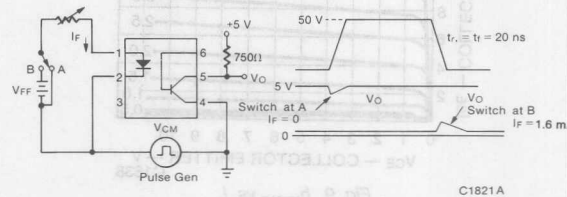
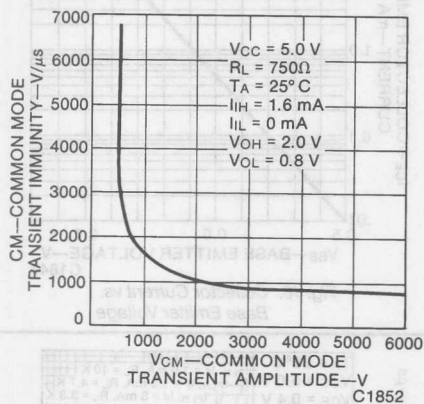
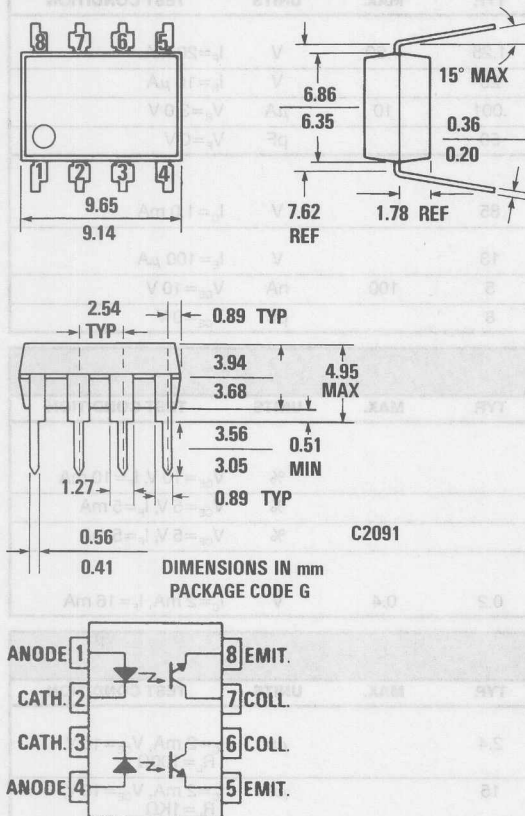


Fig. 14. Common Mode Transient Rejection
& Test Circuit

MCT6 MCT62
MCT61

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The MCT6X optoisolators have two channels for high density applications. For four channel applications, two-packages fit into a standard 16-pin DIP socket. Each channel is an NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES

- Two isolated channels per package
- Two packages fit into a 16 lead DIP socket
- Choice of 3 current transfer ratios
- Underwriters Laboratory (U.L.) recognized File E50151

APPLICATIONS

- AC Line/Digital Logic—Isolate high voltage transients
- Digital Logic/Digital Logic—Eliminate spurious grounds
- Digital Logic/AC Triac Control—Isolate high voltage transients
- Twisted pair line receiver—Eliminate ground loop feedthrough
- Telephone/Telegraph line receiver—Isolate high voltage transients
- High Frequency Power Supply Feedback Control—Maintain floating ground
- Relay contact monitor—Isolate floating grounds and transients
- Power Supply Monitor—Isolate transients

ABSOLUTE MAXIMUM RATINGS

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead temperature (soldering, 10 sec.) 250°C

TOTAL INPUT

Power dissipation at 25°C ambient 100 mW
Derate linearly from 25°C 1.3 mW/°C

COUPLED

Input to output breakdown voltage ... 2500 volts V_{RMS}
Total package power dissipation
@ 25°C ambient 400 mW
Derate linearly from 25°C 5.33 mW/°C

INPUT DIODE (each channel)

Forward current 60 mA
Reverse voltage 3.0 V
Peak forward current (1 μ s pulse, 300 pps) 3 A

OUTPUT TRANSISTOR (each channel)

Power dissipation @ 25°C ambient 150 mW
Derate linearly from 25°C 2 mW/°C
Collector current 30 mA

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
INPUT DIODE						
Rated forward voltage	V_F		1.25	1.50	V	$I_F = 20 \text{ mA}$
Reverse voltage	V_R	3.0	25		V	$I_R = 10 \text{ } \mu\text{A}$
Reverse current	I_R		.001	10	μA	$V_R = 3.0 \text{ V}$
Junction capacitance	C_J		50		pF	$V_F = 0 \text{ V}$
OUTPUT TRANSISTOR ($I_F = 0$)						
Breakdown voltage, collector to emitter	BV_{CEO}	30	85		V	$I_C = 1.0 \text{ mA}$
Breakdown voltage, emitter to collector	BV_{ECO}	6	13		V	$I_E = 100 \text{ } \mu\text{A}$
Leakage current, collector to emitter	I_{CEO}		5	100	nA	$V_{CE} = 10 \text{ V}$
Capacitance collector to emitter	C_{CE}		8		pF	$V_{CE} = 0 \text{ V}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
COUPLED						
DC current transfer ratio (I_C/I_F) = CTR						
MCT6		20			%	$V_{CE} = 10 \text{ V}, I_F = 10 \text{ mA}$
MCT61		50			%	$V_{CE} = 5 \text{ V}, I_F = 5 \text{ mA}$
MCT62		100			%	$V_{CE} = 5 \text{ V}, I_F = 5 \text{ mA}$
Saturation voltage—collector to emitter MCT6, 61, 62	$V_{CE(SAT)}$		0.2	0.4	V	$I_C = 2 \text{ mA}, I_F = 16 \text{ mA}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
SWITCHING TIMES, OUTPUT TRANSISTOR						
Non-saturated rise time, fall time (Note 3)			2.4		μs	$I_C = 2 \text{ mA}, V_{CE} = 10 \text{ V}, R_L = 100 \Omega$
Non-saturated rise time, fall time (Note 3)			15		μs	$I_C = 2 \text{ mA}, V_{CE} = 10 \text{ V}, R_L = 1 \text{ K}\Omega$
Saturated turn-on time (from 5.0V to 0.8V)			5		μs	$R_L = 2 \text{ K}\Omega, I_F = 40 \text{ mA}$
Saturated turn-off time (from saturation to 2.0V)			25		μs	$R_L = 2 \text{ K}\Omega, I_F = 40 \text{ mA}$
Bandwidth B_w			150		kHz	$I_C = 2 \text{ mA}, V_{CE} = 10 \text{ V}, R_L = 100 \Omega$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Isolation voltage	$BV_{(I-O)}$	2500			V_{RMS}	$t = 1 \text{ minute}$
Isolation resistance MCT6X—	$R_{(I-O)}$	10^{11}	10^{12}		Ω	$V_{I-O} = 500 \text{ VDC}$
Breakdown voltage—channel-to-channel MCT6X			500		VDC	Relative humidity = 40% $f = 1 \text{ MHz}$
Capacitance between channels			0.4		pF	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

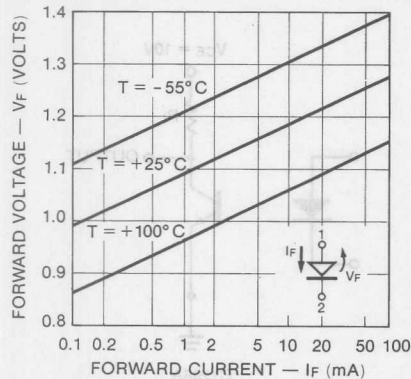


Fig. 1. Forward Voltage vs. Current

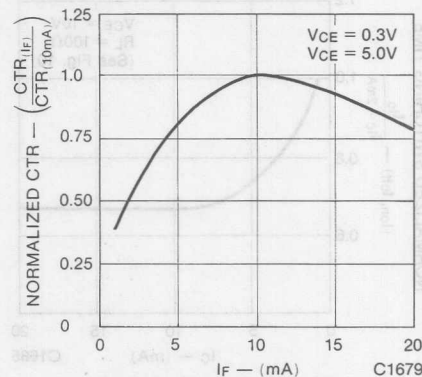


Fig. 2. Normalized CTR vs. Forward Current

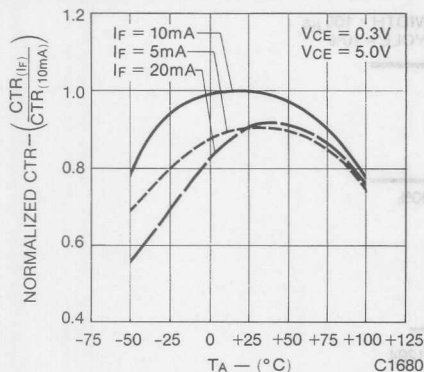


Fig. 3. Normalized CTR vs. Temperature

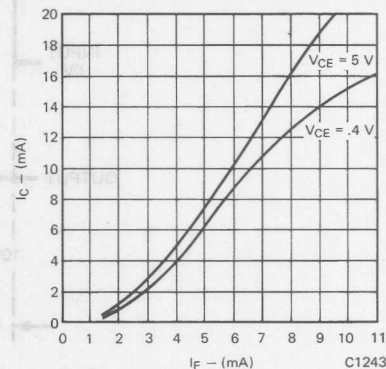


Fig. 4. Collector Current vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

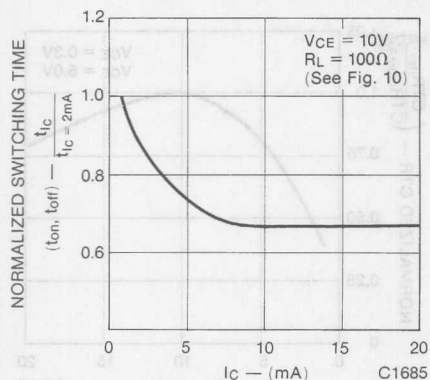


Fig. 5. Switching Time vs. IC

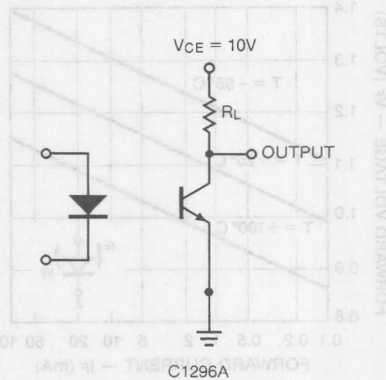


Fig. 6. Switching Time Test Circuit

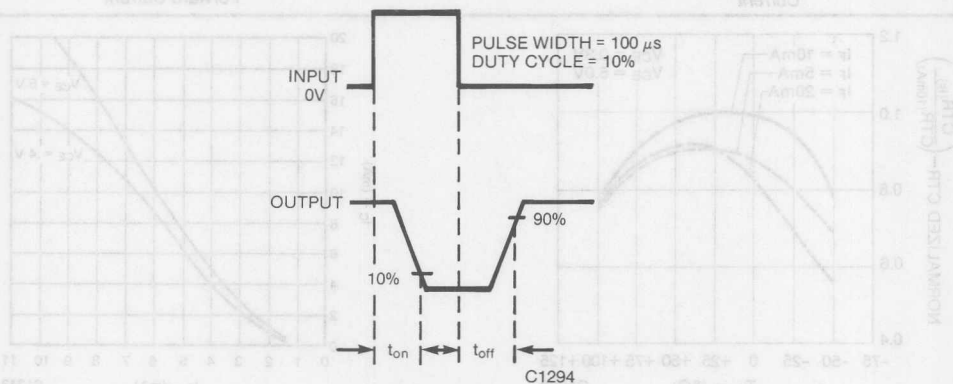


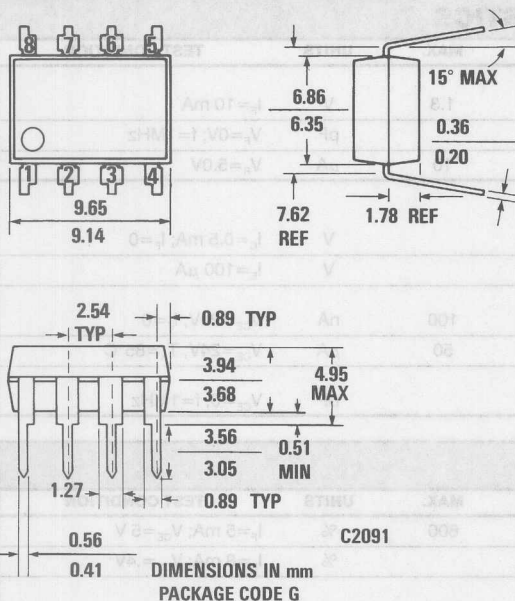
Fig. 7. Switching Time Waveforms

NOTES

1. Normalized CTR degradation = $\frac{CTR_0 - CTR}{CTR_0}$
2. The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
3. The frequency at which i_c is 3 dB down from the 1 kHz value.
4. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value to 90%.
Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

MCT9001

PACKAGE DIMENSIONS



DESCRIPTION

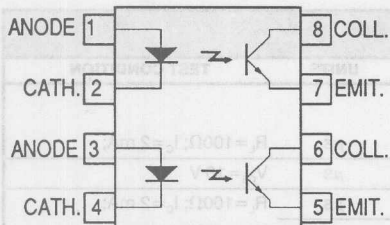
The MCT9001 is a two channel optocoupler in a standard, end stackable, 8 pin dual-in-line package. This part offers the same packing density as 4 pin optocouplers, while minimizing component count and insertion costs.

FEATURES

- Two isolated channels per package
- Two packages fit into a 16 lead DIP socket
- Underwriters Laboratory (UL) recognized File E50151

APPLICATIONS

- High voltage isolation
- Ground loop elimination
- Transient protection
- Common mode noise reduction
- AC line to logic interface
- Telephone line receiver
- Isolated feedback control
- Logic to power interface



ABSOLUTE MAXIMUM RATINGS

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead temperature (soldering, 10 sec)	250°C
INPUT DIODE (each channel)	
Forward current	60 mA
Reverse voltage	5.0 V
Peak forward current (1 μ s pulse, 300 pps)	3 A
TOTAL INPUT	
Power dissipation 25°C ambient	100 mW
Derate linearly from 25°C	1.1 mW/°C

OUTPUT TRANSISTOR (each channel)

Power dissipation at 25°C ambient	150 mW
Derate linearly from 25°C	1.67 mW/°C
Collector current	50 mA

COUPLED

Input to output breakdown voltage	2500V _{RMS}
Total package power dissipation at 25°C ambient	400 mW
Derate linearly from 25°C	4.83 mW/°C

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
INPUT DIODE						
Forward voltage	V_F		1.0	1.3	V	$I_F = 10 \text{ mA}$
Junction capacitance	C_J		50		pF	$V_F = 0\text{V}; f = 1 \text{ MHz}$
Reverse leakage current	I_R			10	μA	$V_R = 5.0\text{V}$
OUTPUT TRANSISTOR						
Breakdown voltage Collector to emitter	BV_{CEO}	55			V	$I_C = 0.5 \text{ mA}; I_F = 0$
Emitter to collector	BV_{ECO}	7			V	$I_E = 100 \mu\text{A}$
Leakage current Collector to emitter	I_{CEO}			100	nA	$V_{CE} = 24\text{V}; I_F = 0$
				50	μA	$V_{CE} = 24\text{V}; T_A = 85^\circ\text{C}$
Capacitance Collector to emitter			8		pF	$V_{CE} = 0; f = 1 \text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Current transfer ratio	CTR_{CE}	50		600	%	$I_F = 5 \text{ mA}; V_{CE} = 5 \text{ V}$
Saturated current	$CTR_{CE(SAT)}$	30			%	$I_F = 8 \text{ mA}; V_{CE} = .4\text{V}$
transfer ratio						
Saturation voltage	$V_{CE(SAT)}$			0.4	V	$I_F = 8 \text{ mA}; I_C = 2.4 \text{ mA}$

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
SWITCHING TIMES						
Non-saturated						
Rise time	t_r		2.4		μs	$R_L = 100\Omega; I_C = 2 \text{ mA}; V_{CE} = 10 \text{ V}$
Fall time	t_f		2.4		μs	
Turn on time	t_{on}		3.0		μs	$R_L = 100\Omega; I_C = 2 \text{ mA}; V_{CE} = 10 \text{ V}$
Turn off time	t_{off}		3.0		μs	
Saturated						
Turn on time	t_{on}		2.4		μs	$I_F = 16 \text{ mA}; R_L = 1.9\text{K}\Omega$
Turn off time	t_{off}		25.0		μs	$V_{CE} = 5 \text{ V}$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
Surge isolation voltage	V_{ISO}	4000			VDC	Relative humidity $\leq 50\%$; $I_{IO} \leq 10 \mu\text{A}$
		3000			VAC-rms	1 second
Steady state isolation voltage	V_{ISO}	3500			VDC	Relative humidity $\leq 50\%$; $I_{IO} \leq 10 \mu\text{A}$
		2500			VAC-rms	1 minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{IO} = 500 \text{ VDC}$
Isolation capacitance	C_{ISO}		0.5		pF	$f = 1 \text{ MHz}$

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

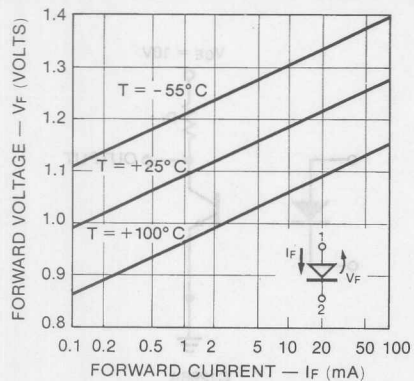


Fig. 1. Forward Voltage vs. Current

C1686

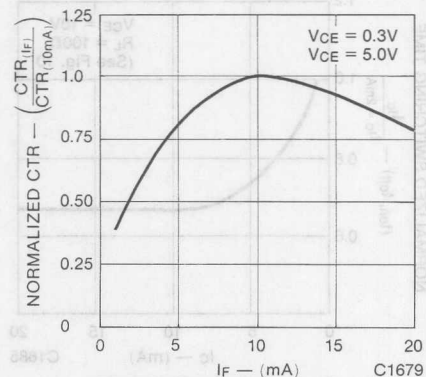


Fig. 2. Normalized CTR vs. Forward Current

C1679

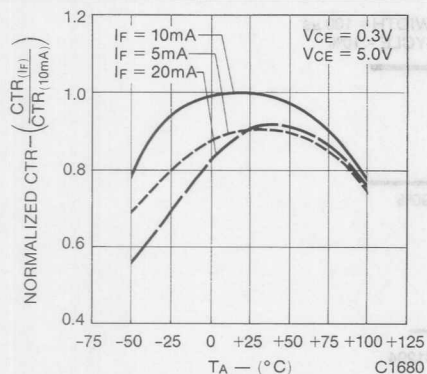


Fig. 3. Normalized CTR vs. Temperature

C1680

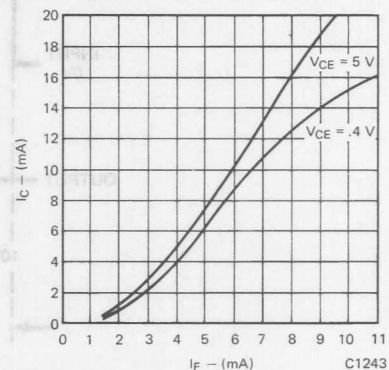


Fig. 4. Collector Current vs. Forward Current

C1243

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

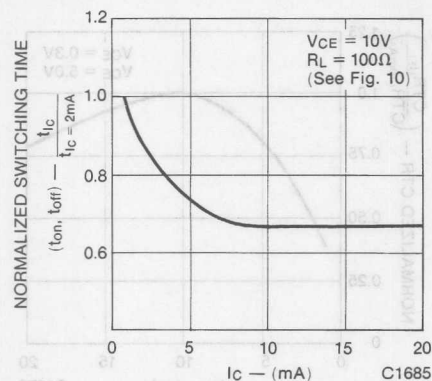


Fig. 5. Switching Time vs. I_C

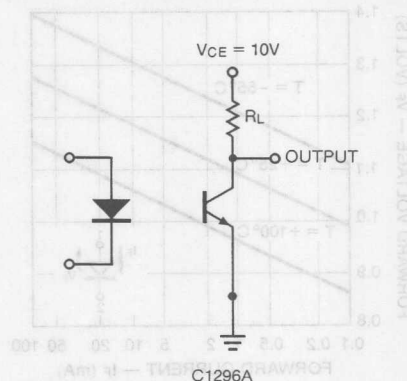


Fig. 6. Switching Time Test Circuit

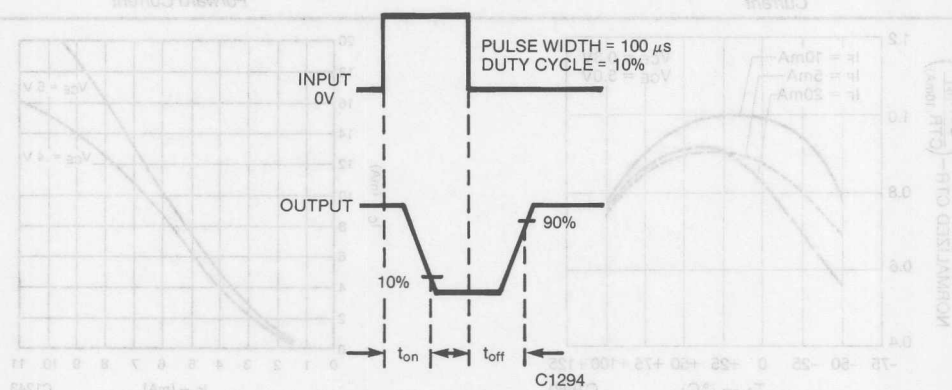
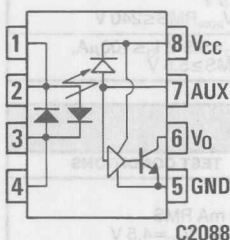
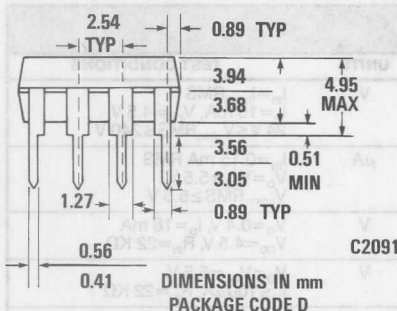
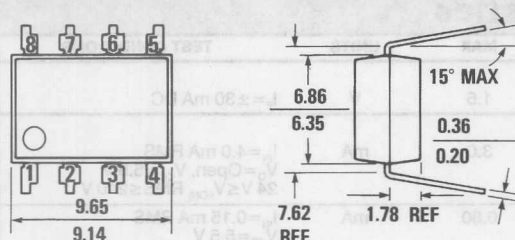


Fig. 7. Switching Time Waveforms

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a logic low condition.

The MID400 has been designed solely for use as an AC line **monitor**. It is recommended for use in any AC-to-DC control application where excellent optical isolation, solid state reliability, TTL compatibility, small size, low power, and low frequency operation are required.

FEATURES

- Direct operation from any line voltage with the use of an external resistor
- Externally adjustable time delay
- Externally adjustable AC voltage sensing level
- High voltage isolation between input and output
- Compact plastic DIP package
- Logic level compatibility
- UL recognized (File #E50151)

APPLICATIONS

- Monitoring of the AC/DC "line-down" condition
- "Closed-loop" interface between electromechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

ABSOLUTE MAXIMUM RATINGS

INPUT—LED CIRCUIT

RMS current	25 mA
DC current	±30 mA
Power dissipation at 25°C ambient	45 mW
Derate linearly from 70°C	2.0 mW/°C

OUTPUT—DETECTOR CIRCUIT

Low level output current (I_{OL})	20 mA
High level output voltage (V_{OH})	7.0 V
Supply voltage (V_{CC})	7.0 V
Power dissipation at 25°C ambient	70 mW
Derate linearly from 70°C	2.0 mW/°C

TOTAL PACKAGE

Storage temperature	−55°C to +125°C
Operating temperature	−40°C to +85°C
Lead soldering temperature, 10 sec.	260°C
Power dissipation at 25°C ambient	115 mW
Derate linearly from 70°C	4.0 mW/°C
Surge isolation	3550 VDC
	2500 V RMS
Steady state isolation	3200 VDC
	2250 V RMS

ELECTRICAL CHARACTERISTICS

(0°C to 70°C Free Air Temperature Unless Otherwise Specified—All Typical Values Are At 25°C)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
INPUT LED Forward Voltage	V_F			1.5	V	$I_F = \pm 30$ mA DC
DETECTOR Logic Low Output Supply Current	I_{CCL}			3.0	mA	$I_{IN} = 4.0$ mA RMS $V_O = \text{Open}$, $V_{CC} = 5.5$ V $24 \text{ V} \leq V_{(ON)} \text{ RMS} \leq 240 \text{ V}$
Logic High Output Supply Current	I_{CCH}			0.80	mA	$I_{IN} = 0.15$ mA RMS $V_{CC} = 5.5$ V $V_{(OFF)} \text{ RMS} \geq 5.5$ V

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Logic Low Output Voltage	V_{OL}		.18	0.40	V	$I_{IN} = I_{(ON)} \text{ RMS}$ $I_O = 16$ mA, $V_{CC} = 4.5$ V $24 \text{ V} \leq V_{(ON)} \text{ RMS} \leq 240 \text{ V}$
Logic High Output Current	I_{OH}		.02	100	μA	$I_{IN} = 0.15$ mA RMS $V_O = V_{CC} = 5.5$ V $V_{(OFF)} \text{ RMS} \geq 5.5$ V
On-state RMS Input Voltage	$V_{(ON)} \text{ RMS}$	90			V	$V_O = 0.4$ V, $I_O = 16$ mA $V_{CC} = 4.5$ V, $R_{IN} = 22 \text{ K}\Omega$
Off-state RMS Input Voltage	$V_{(OFF)} \text{ RMS}$			5.5	V	$V_O = V_{CC} = 5.5$ V, $I_O \leq 100 \mu\text{A}$, $R_{IN} = 22 \text{ K}\Omega$
On-state RMS Input Current	$I_{(ON)} \text{ RMS}$	4.0			mA	$V_O = 0.4$ V, $I_O = 16$ mA $V_{CC} = 4.5$ V $24 \text{ V} \leq V_{(ON)} \text{ RMS} \leq 240 \text{ V}$
Off-state RMS Input Current	$I_{(OFF)} \text{ RMS}$			.15	mA	$V_O = V_{CC} = 5.5$ V, $I_O \leq 100 \mu\text{A}$, $V_{(OFF)} \text{ RMS} \geq 5.5$ V

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
SWITCHING TIME ($T_A = +25^\circ\text{C}$) Turn-On Time	t_{ON}		1.0		mS	$I_{IN} = 4.0$ mA RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $R_{IN} = 22 \text{ K}\Omega$ (See Test Circuit 2)
Turn-Off Time	t_{OFF}		1.0		mS	$I_{IN} = 4.0$ mA RMS $I_O = 16$ mA, $V_{CC} = 4.5$ V $R_{IN} = 22 \text{ K}\Omega$ (See Test Circuit 2)

ISOLATION CHARACTERISTICS ($T_A = +25^\circ\text{C}$)

CHARACTERISTICS	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Surge Isolation Voltage	V_{ISO}	3550			VDC	Relative Humidity $\leq 50\%$, $I_{IO} \leq 10 \mu\text{A}$
		2500			VACRMS	1 Second, 60 Hz
Steady State Isolation Voltage	V_{ISO}	3200			VDC	Relative Humidity $\leq 50\%$, $I_{IO} \leq 10 \mu\text{A}$
		2250			VACRMS	1 Minute, 60 Hz
Isolation Resistance	R_{ISO}	10^{11}			Ω	$V_{IO} = 500$ VDC
Isolation Capacitance	C_{ISO}		2		pF	$f = 1 \text{ MHz}$

(RMS=True RMS Voltage at 60 Hz, THD $\leq 1\%$.)

DESCRIPTION/APPLICATIONS

The input of the MID400 consists of two back-to-back LED diodes which will accept and convert alternating currents into light energy. An integrated photo diode-detector amplifier forms the output network. Optical coupling between input and output provides 3550 V DC voltage isolation. A very high current transfer ratio, (defined as the ratio of the DC output current and the DC input current) is achieved through the use of a high gain amplifier. The detector amplifier circuitry operates from a 5 V DC supply and drives an open collector transistor output. The switching times are intentionally designed to be slow in order to enable the MID400, when used as an AC line monitor, to respond only to changes of input voltage exceeding many milliseconds. The short period of time during zero-crossing which occurs once every half cycle of the power line is completely ignored. To operate the MID400, always add a resistor, R_{IN} , in series with the input (as shown in test circuit 1) to limit the current to the required value. The value of the resistor can be determined by the following equation:

$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

Where V_{IN} (RMS) is the input voltage.

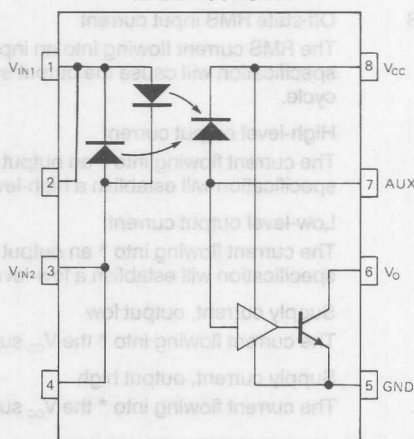
V_F is the forward voltage drop across the LED.

I_{IN} (RMS) is the desired input current required to sustain a logic "O" on the output.

PIN DESCRIPTION

DESIGNATION	PIN #	FUNCTION
V_{IN1}, V_{IN2}	1, 3	Input terminals.
V_{CC}	8	Supply voltage, output circuit.
AUX.	7	Auxiliary terminal.
		Programmable capacitor input to adjust AC voltage sensing level and time delay.
V_O	6	Output terminal; open collector.
GND	5	Circuit ground potential.

SCHEMATIC DIAGRAM



NOTE: DO NOT CONNECT PIN 2 AND 4

GLOSSARY

VOLTAGES

- $V_{I(ON)}$ RMS** On-state RMS input voltage
The RMS voltage at an input terminal for a specified input current with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.
- $V_{I(OFF)}$ RMS** Off-state RMS input voltage
The RMS voltage at an input terminal for a specified input current with output conditions applied that according to the product specification will cause the output switching element to be sustained in the off-state within one full cycle.
- V_{OL}** Low-level output voltage
The voltage at an output terminal for a specific output current I_{OL} with input conditions applied that according to the product specification will establish a low-level at the output.
- V_{OH}** High-level output voltage
The voltage at an output terminal for a specified output current I_{OH} with input conditions applied that according to the product specification will establish a high-level at the output.
- V_F** LED forward voltage
The voltage developed across the LED when input current I_F is applied to the anode of the LED.

CURRENTS

- $I_{I(ON)}$ RMS** On-state RMS input current
The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.
- $I_{I(OFF)}$ RMS** Off-state RMS input current
The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the off-state within one full cycle.
- I_{OH}** High-level output current
The current flowing into * an output with input conditions applied that according to the product specification will establish a high-level at the output.
- I_{OL}** Low-level output current
The current flowing into * an output with input conditions applied that according to the product specification will establish a low-level at the output.
- I_{CCL}** Supply current, output low
The current flowing into * the V_{CC} supply terminal of a circuit when the output is at a low-level voltage.
- I_{CCH}** Supply current, output high
The current flowing into * the V_{CC} supply terminal of a circuit when the output is at a high-level voltage.

DYNAMIC CHARACTERISTICS

- t_{ON}** Turn-on time
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined high-level to the defined low-level.
- t_{OFF}** Turn-off time
The time between the specified reference points on the input and output voltage waveforms with the output changing from the defined low-level to the defined high-level.

*Current flowing out of a terminal is a negative value.

C1478A

*INPUT TURNS ON AND OFF AT ZERO CROSSING.

Test Circuit 2 MID400 Switching Time

C1479B

TYPICAL CURVES

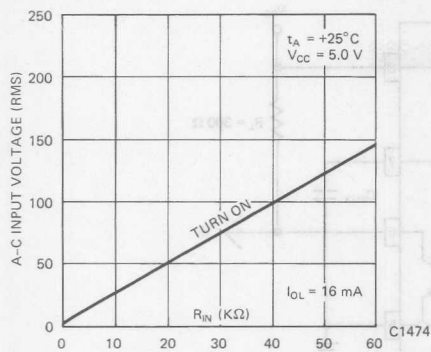


Fig. 2. Input Voltage vs. Input Resistance

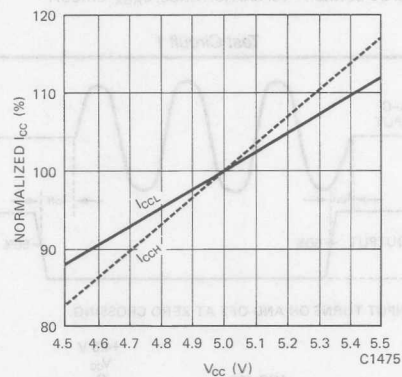
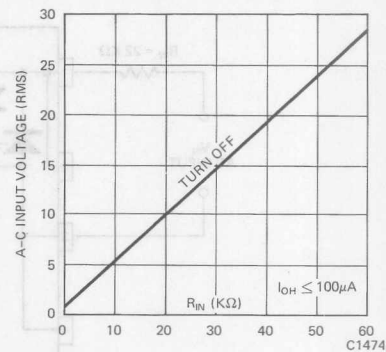
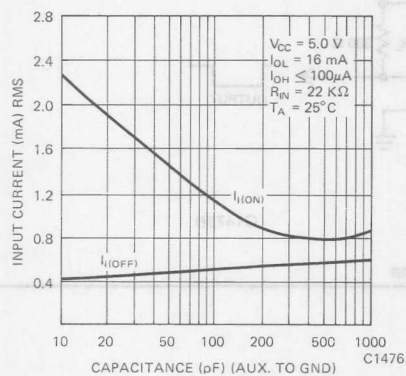
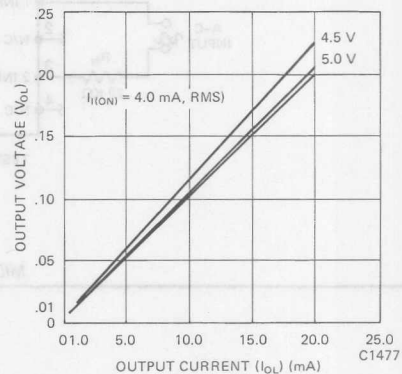
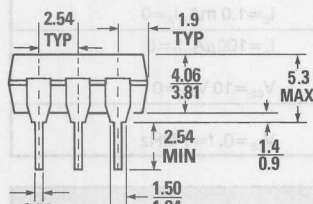
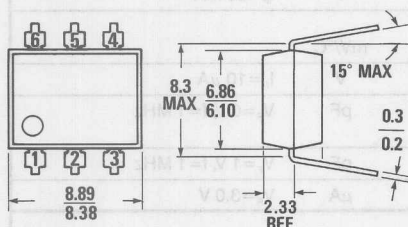


Fig. 3. Supply Current vs. Supply Voltage

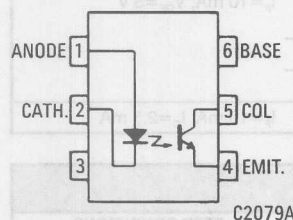
Fig. 4. Input Current vs. Capacitance
(See test circuit 1)Fig. 5. Output Voltage vs.
Output Current

**MOC8111
MOC8112
MOC8113**

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K ST1603A



Equivalent Circuit

DESCRIPTION

The MOC series consists of a Gallium Arsenide IRED coupled with an NPN phototransistor.

FEATURES

- High isolation voltage
5300 VAC RMS—1 minute
7500 VAC PEAK—1 minute
- High BV_{CEO} minimum 70 volts
- Current transfer ratio in selected groups:
MOC8111: 20% min.
MOC8112: 50% min.
MOC8113: 100% min.
- Maximum switching time in saturation specified
- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	—55°C to 150°C
Operating temperature	—55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation @ 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.5 mW/°C

INPUT DIODE

Forward DC current	90 mA
Reverse voltage	6 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	135 mW
Derate linearly from 25°C	1.8 mW/°C

OUTPUT TRANSISTOR

Power dissipation @ 25°C	200 mW
Derate linearly from 25°C	2.67 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.3	1.50	V	$I_F = 60 \text{ mA}$
Forward voltage temp. coefficient	$\frac{\Delta V_F}{\Delta T_A}$		-1.8		mV/°C	
Reverse voltage	V_R	6.0	15		V	$I_R = 10 \mu\text{A}$
Junction capacitance	C_J		50		pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
			65		pF	$V_F = 1 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R		.35	10	μA	$V_R = 3.0 \text{ V}$
OUTPUT TRANSISTOR						
Breakdown voltage						
Collector to emitter	BV_{CEO}	70			V	$I_C = 1.0 \text{ mA}, I_F = 0$
Emitter to collector	BV_{ECO}	7			V	$I_E = 100 \mu\text{A}, I_F = 0$
Leakage current						
Collector to emitter	I_{CEO}		5	50	nA	$V_{CE} = 10 \text{ V}, I_F = 0$
Capacitance						
Collector to emitter			8		pF	$V_{CE} = 0, f = 1 \text{ MHz}$

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Current Transfer Ratio, collector to emitter	CTR				%	$I_F = 10 \text{ mA}; V_{CE} = 5 \text{ V}$
MOC8111		20				
MOC8112		50				
MOC8113		100				
Saturation voltage	$V_{CE(SAT)}$		0.27	.40	V	$I_F = 10 \text{ mA}; I_C = 2.5 \text{ mA}$

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING TIMES						
Non-saturated						$R_L = 100 \Omega; I_C = 2 \text{ mA}; V_{CC} = 10 \text{ V}$
Turn-on time	t_{on}		6.0	10	μs	
Turn-off time	t_{off}		5.5	10	μs	See Fig. 10.

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Temperature Unless Otherwise Specified) (Cont'd)

TRANSFER CHARACTERISTICS (Cont'd)

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SATURATED SWITCHING TIMES						
Turn-on time	t_{on}					
MOC8111			3.0	5.5	μS	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
MOC8112, MOC8113			4.2	8.0	μS	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Rise-time	t_r					
MOC8111			2.0	4.0	μS	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
MOC8112, MOC8113			3.0	6.0	μS	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Turn-off time	t_{off}					
MOC8111			18	34	μS	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
MOC8112, MOC8113			23	39	μS	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
Fall-time	t_f					
MOC8111			11	20	μS	$I_F = 20 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$
MOC8112, MOC8113			14	24	μS	$I_F = 10 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{iso}	5300			$V_{AC} \text{ RMS}$	$I_{FO} \leq 1 \mu A$, 1 minute
	V_{iso}	7500			$V_{AC} \text{ PEAK}$	$I_{FO} \leq 1 \mu A$, 1 minute
Isolation resistance	R_{iso}	10^{11}			ohms	$V_{FO} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}		0.5		pF	$f = 1 \text{ MHz}$

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

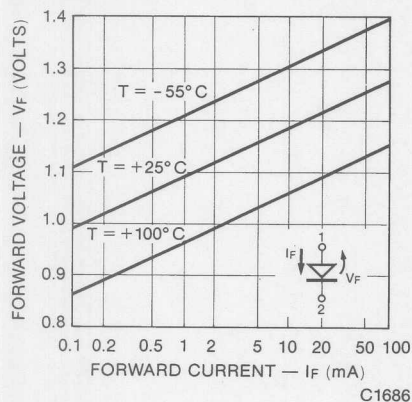


Fig. 1. Forward Voltage vs. Current

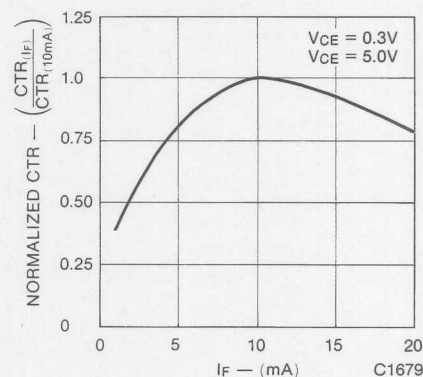


Fig. 2. Normalized CTR vs. Forward Current

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

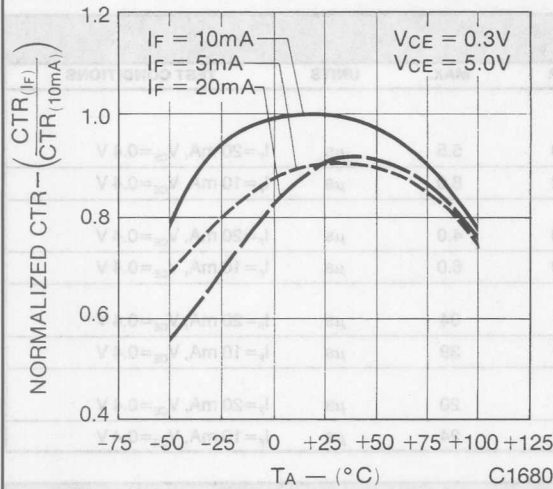


Fig. 3. Normalized CTR vs. Temperature

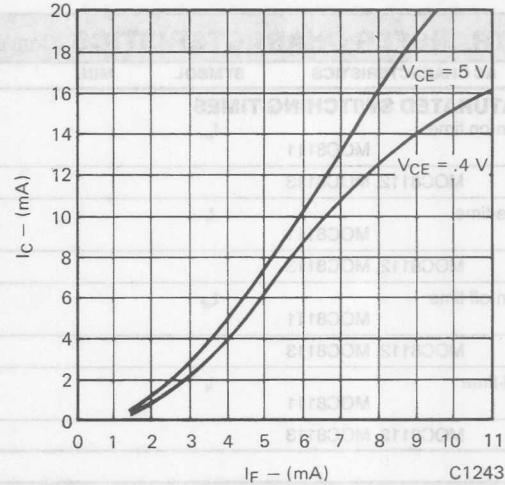


Fig. 4. Collector Current vs. Forward Current

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{CE}	5000			V _{DC}	$I_F \leq 10 \text{ mA}$, 1 minute
Isolation resistance	R_{iso}	10 ⁷			ohms	$V_{CE} = 500 \text{ VDC}$
Isolation capacitance	C_{iso}	0.5			pf	$f = 1 \text{ MHz}$

MOC8111 MOC8112 MOC8113

ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

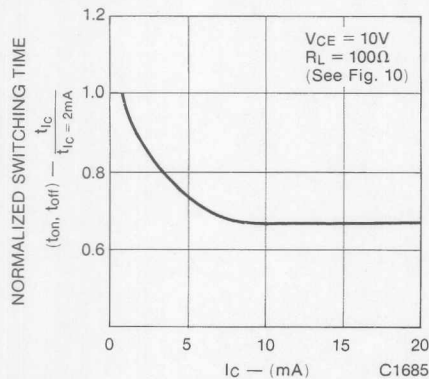


Fig. 5. Switching Time vs. I_C

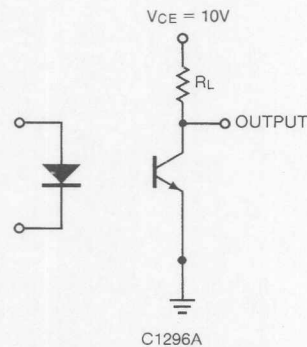


Fig. 6. Switching Time Test Circuit

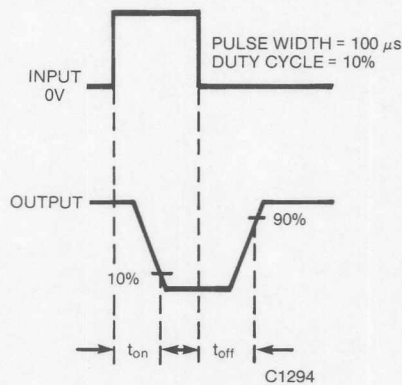


Fig. 7. Switching Time Waveforms

OPTICAL CHARACTERISTICS

ICL 660A, 660B, 660C, 660D, 660E, 660F, 660G, 660H, 660I, 660J, 660K, 660L, 660M, 660N, 660P, 660Q, 660R, 660S, 660T, 660U, 660V, 660W, 660X, 660Y, 660Z

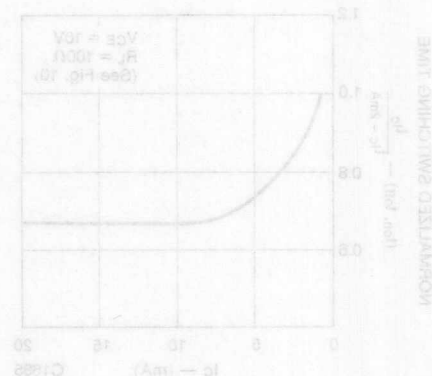


Fig. 2. Switching Time vs. I_C

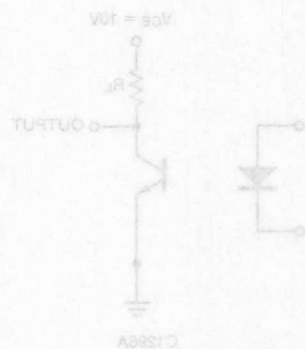


Fig. 6. Switching Time Test Circuit

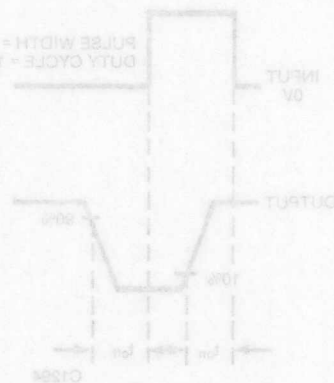
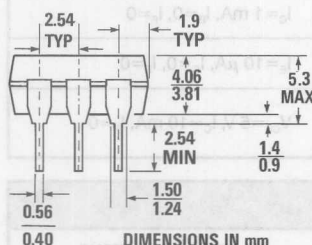
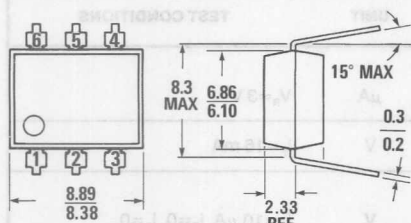


Fig. 7. Switching Time Waveforms

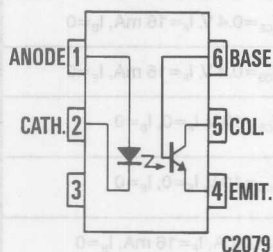
TIL111

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



DESCRIPTION

The TIL111 is a phototransistor-type optically coupled isolator. An infrared emitting diode manufactured from specially grown gallium arsenide is selectively coupled with an NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

FEATURES

- Underwriters Laboratory (UL) recognized File #E90700

APPLICATIONS

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

TOTAL PACKAGE

Storage temperature	-55°C to 150°C
Operating temperature	-55°C to 100°C
Lead temperature (soldering, 10 sec)	260°C
Total package power dissipation at 25°C (LED plus detector)	260 mW
Derate linearly from 25°C	3.3 mW/°C

INPUT DIODE

Forward DC current	100 mA
Reverse voltage	3 V
Peak forward current (1 μs pulse, 300 pps)	3.0 A
Power dissipation 25°C ambient	150 mW
Derate linearly from 25°C	2 mW/°C

OUTPUT TRANSISTOR

Power dissipation at 25°C	150 mW
Derate linearly from 25°C	2 mW/°C
V_{CEO}	30 V
V_{CEO}	70 V
V_{ECO}	7 V
Collector current (continuous)	100 mA

ELECTRICAL CHARACTERISTICS (At 25°C Free-Air Temperature)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	TIL111			UNIT	TEST CONDITIONS
		MIN.	TYP.	MAX.		
INPUT DIODE Input diode static reverse current	I_R			10	μA	$V_R = 3 V$
Input diode static forward voltage	V_F		1.2	1.4	V	$I_F = 16 mA$
OUTPUT TRANSISTOR Collector-base breakdown voltage	$V_{(BR)CBO}$	70			V	$I_C = 10 \mu A, I_E = 0, I_F = 0$
Collector-emitter breakdown voltage	$V_{(BR)CEO}$	30			V	$I_C = 1 mA, I_B = 0, I_F = 0$
Emitter-base breakdown voltage	$V_{(BR)EBO}$	7			V	$I_E = 10 \mu A, I_C = 0, I_F = 0$
Transistor static forward current transfer ratio	h_{FE}	100	300			$V_{CE} = 5 V, I_C = 10 mA, I_F = 0$

TRANSFER CHARACTERISTICS

PARAMETER	SYMBOL	TIL111			UNIT	TEST CONDITIONS
		MIN.	TYP.	MAX.		
On-state collector current	Phototransistor operation	$I_{C(on)}$	2	7	mA	$V_{CE} = 0.4 V, I_F = 16 mA, I_B = 0$
	Photodiode operation	$I_{C(on)}$	7	20	μA	$V_{CB} = 0.4 V, I_F = 16 mA, I_E = 0$
Off-state collector current	Phototransistor operation	$I_{C(off)}$		1	nA	$V_{CE} = 10 V, I_F = 0, I_B = 0$
	Photodiode operation	$I_{C(off)}$		0.1	nA	$V_{CB} = 10 V, I_F = 0, I_E = 0$
Collector-emitter saturation voltage	$V_{CE(sat)}$		0.25	0.4	V	$I_C = 2 mA, I_F = 16 mA, I_B = 0$

SWITCHING CHARACTERISTICS (At 25°C Free-Air Temperature)

PARAMETER	SYMBOL	TIL111			UNIT	TEST CONDITIONS
		MIN.	TYP.	MAX.		
Rise time	Phototransistor operation	t_r	5	10	μs	$V_{CC} = 10 V, I_{C(on)} = 2 mA, R_L = 100 \Omega$
Fall time	Phototransistor operation	t_f				
Rise time	Photodiode operation	t_r	1		μs	$V_{CC} = 10 V, I_{C(on)} = 20 \mu A, R_L = 1 k\Omega$
Fall time	Photodiode operation	t_f				

ISOLATION CHARACTERISTICS

PARAMETER	SYMBOL	TIL111			UNIT	TEST CONDITIONS
		MIN.	TYP.	MAX.		
Input-to-output internal resistance	r_{io}	10^{11}			Ω	$V_{ISO} = \pm 1.5 kV$
Input-to-output capacitance	C_{io}		1	1.3	pF	$V_{in-out} = 0, f = 1 MHz, \text{ See Note 6}$
Isolation voltage	V_{iso}	7500 5300			VAC-PEAK	$I_{I-O} \leq 1 \mu A, 1 \text{ minute}$
					VAC-RMS	$I_{I-O} \leq 1 \mu A, 1 \text{ minute}$

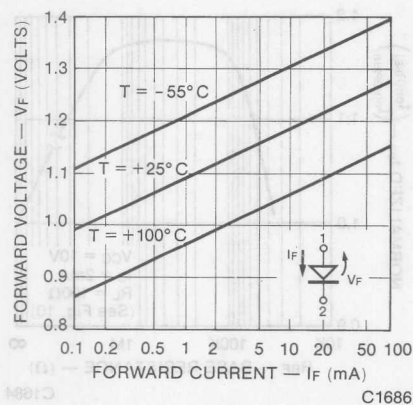


Fig. 1. Forward Voltage vs. Current

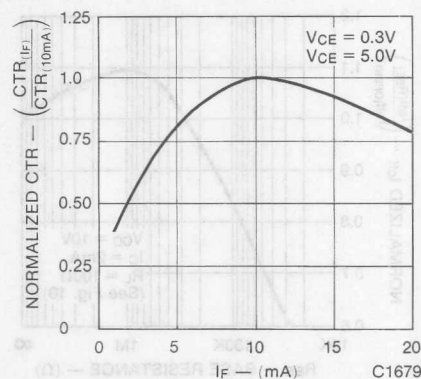


Fig. 2. Normalized CTR vs. Forward Current

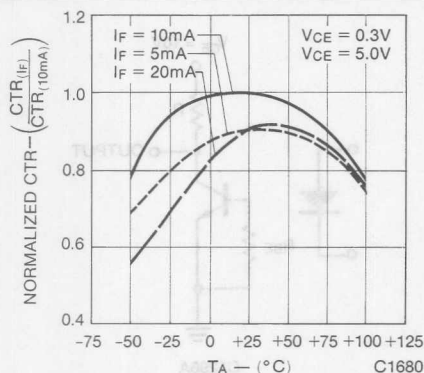


Fig. 3. Normalized CTR vs. Temperature

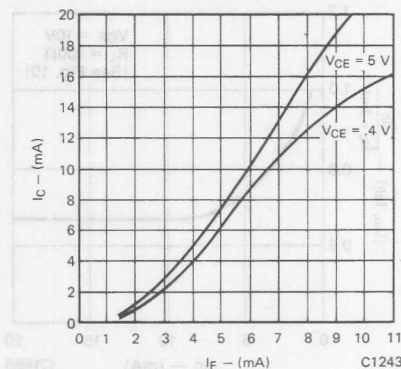


Fig. 4. Collector Current vs. Forward Current

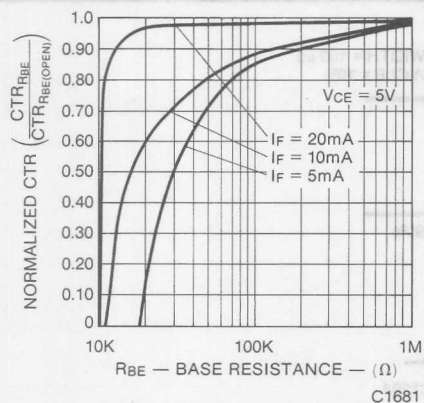


Fig. 5. CTR vs. R_{BE} (Unsaturated)

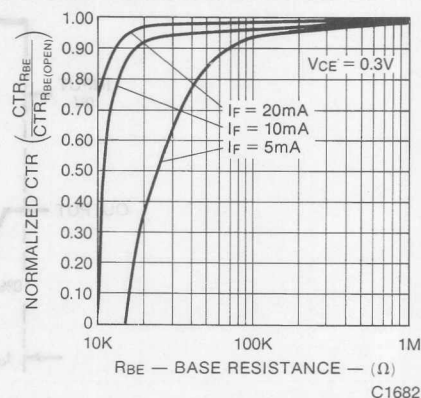


Fig. 6. CTR vs. R_{BE} (Saturated)

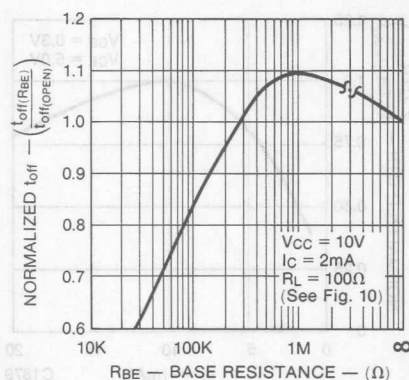


Fig. 7. Normalized T_{OFF} vs. R_{BE}

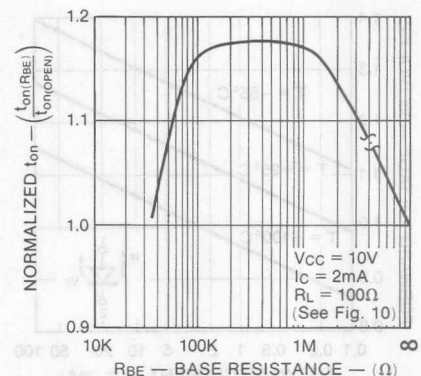


Fig. 8. Normalized T_{ON} vs. R_{BE}

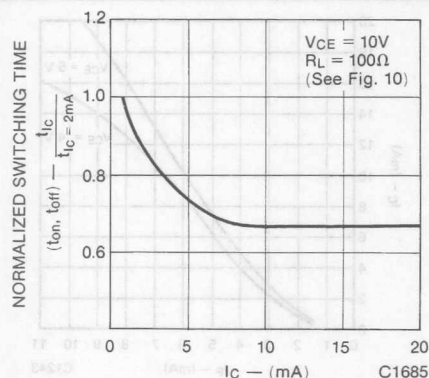


Fig. 9. Switching Time vs. I_C

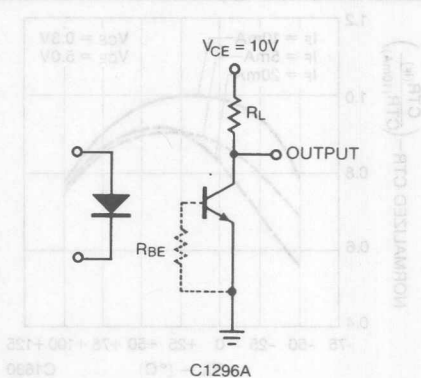


Fig. 10. Switching Time Test Circuit

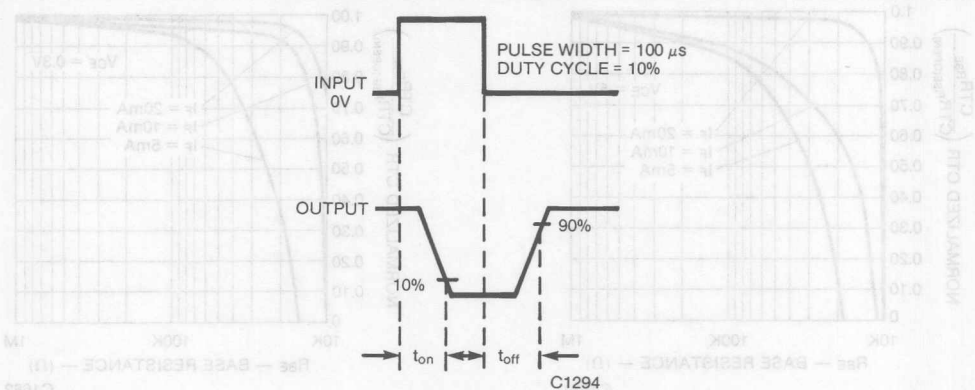


Fig. 11. Switching Time Waveforms

An optocoupler is a combination of a light source and a photo-sensitive detector. In the optocoupler, or photon coupled pair, the coupling is achieved by light being generated on one side of a transparent insulating gap and being detected on the other side of the gap without an electrical connection between the two sides (except for a minor amount of coupling capacitance). In the Quality Technologies optocouplers, the light is generated by an infrared light emitting diode, and the photo-detector is a silicon diode, transistor, or SCR. The sensitivity of the silicon material peaks at the wavelength emitted by the LED, giving maximum signal coupling.

Since the input to all the optocouplers is a LED, the input characteristics will be the same, independent of the type of detector employed. The LED diode characteristics are shown in Figure 1. The forward bias current threshold is shown at approximately 1 volt, and the current increases exponentially, the useful range of I_F between 1 mA and 100 mA being delivered at a V_F between 1.2 and 1.3 volts. The dynamic values of the forward bias impedance are current dependent and are shown on the insert graph for R_{DF} and ΔR as defined in the figure. Reverse leakage is in the nanoampere range before avalanche breakdown.

The LED equivalent circuit is represented in Figure 2, along with typical values of the components. The diode equations are provided if needed for computer modeling and the constants of the equations are given for the IR LED's. Note that the junction capacitance is large and increases with applied forward voltage. An actual plot of this capacitance variation with applied voltage is shown on the graph of Figure 3. It is this large capacitance controlled by the driver impedance which influences the pulse response of the LED. The capacitance must be charged before there is junction current to create light emission. This effect causes an inherent delay of 10-20 nanoseconds or more between applied current and light emission in fast pulse conditions.

The LED is used in the forward biased mode. Since the current increases very rapidly above threshold, the device should always be driven in a current mode, not voltage driven. The simplest method of achieving the current drive is to provide a series current-limiting resistor, as shown in Figure 4, such that the difference

between V_F and V_{APP} is dropped across the resistor at the desired I_F , determined from other criteria. A silicon diode is shown installed inversely parallel to the LED. This diode is used to protect the reverse breakdown of the LED and is the simplest method of achieving this protection. The LED must be protected from excessive power dissipation in the reverse avalanche region. A small amount of reverse current will not harm the LED, but it must be guarded against unexpected current surges.

The forward voltage of the LED has a negative temperature coefficient of 1.05 mW/°C and the variation is shown in Figure 5.

The brightness of the IR LED showly decreases in an exponential fashion as a function of forward current (I_F) and time. The amount of light degradation is graphed in Figure 6 which is based on experimental data out to 20,000 hours. A 50% degradation is considered to be the failure point. This degradation must be considered in the initial design of optoisolator circuits to allow for the decrease and still remain within design specifications on the current-transfer-ratio (CTR) over the design lifetime of the equipment. Also, a limitation on I_F drive is shown to extend useful lifetime of the device.

In some circumstances it is desirable to have a definite threshold for the LED above the normal 1.1 volts of the diode V_F . This threshold adjustment can be obtained by shunting the LED by a resistor, the value of which is determined by a ratio between the applied voltage, the series resistor, and the desired threshold. The circuit of Figure 7 shows the relationship between these values. The calculations will determine the resistor values required for a given I_{FT} and V_A . It is also quite proper to connect several LED's in series to share the same I_F . The V_F of the series is the sum of the individual V_F 's. Zener diodes may also be used in series.

Where the input applied voltage is reversible or alternating and it is desired to detect the phase or polarity of the input, the bipolar input circuit of Figure 8 can be employed. The individual optocouplers could control different functions or be paralleled to become polarity independent. Note that in this connection, the LED's protect each other in reverse bias.

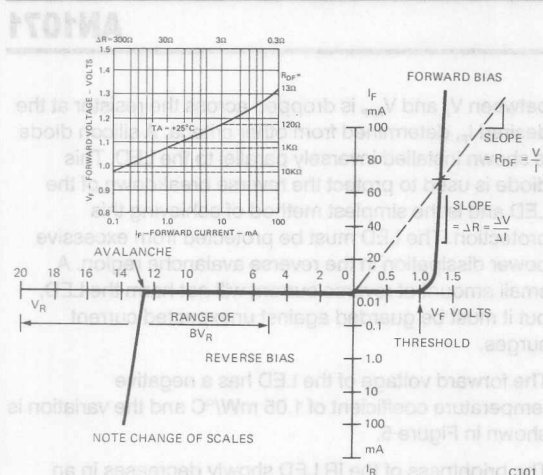


Fig. 1. Characteristics of IR LED

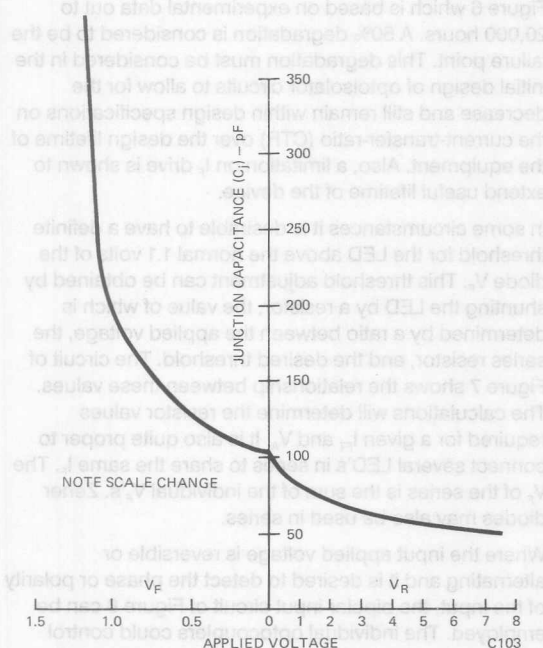


Fig. 3. Voltage Dependence of Junction Capacitance

$$I_F = I_{FT} \exp \frac{V_F - V_{FT}}{k}$$

$$V_F = V_{FT} + k \log \frac{I_F}{I_{FT}}$$

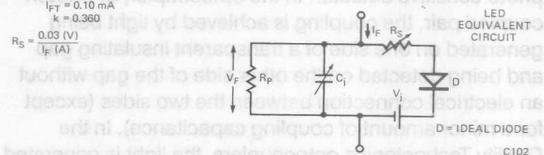
FOR IR IN OPTO-ISOLATORS

$$V_{FT} = 0.98 \text{ VOLT}$$

$$I_{FT} = 0.10 \text{ mA}$$

$$k = 0.360$$

$$R_s = \frac{0.03 \text{ (V)}}{I_F \text{ (A)}}$$



V_F	-5	0	-	-	-	V
I_F	-	-	1	10	100	mA
C_1	55	100	300	500	-	pF
V_1	1.0	1.1	1.2	1.3	-	V
I_R	<10	0	-	-	-	nA
R_s	∞	30	3	0.3	-	Ω
R_p	>10 ⁶	-	-	-	-	Ω

$$I_F = I_{FT} \exp \frac{V_F - V_{FT}}{k}$$

$$V_F = V_{FT} + k \log \frac{I_F}{I_{FT}}$$

FOR IR IN OPTO-ISOLATORS

$$V_{FT} = 0.98 \text{ VOLT}$$

$$I_{FT} = 0.10 \text{ mA}$$

$$k = 0.360$$

$$R_s = \frac{0.03 \text{ (V)}}{I_F \text{ (A)}}$$

Fig. 2. Equivalent Circuit Equations

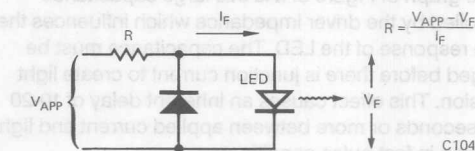


Fig. 4. Typical LED Drive Circuit

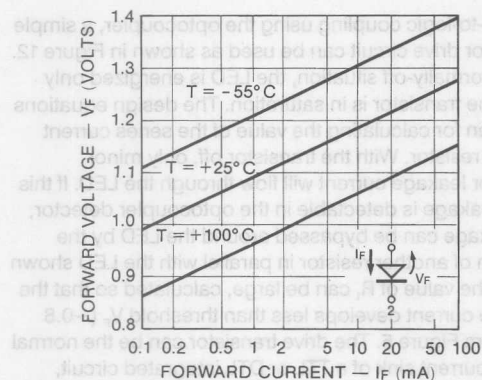


Fig. 5. IR Forward Voltage vs. Forward Current and Temperature

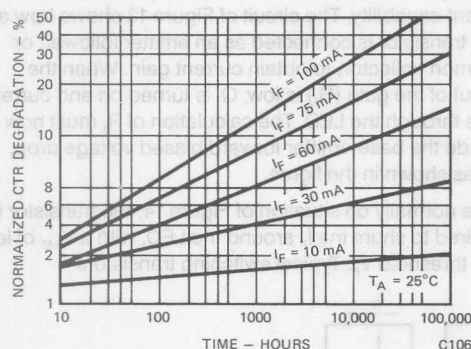


Fig. 6. Brightness Degradation vs. Forward Current and Time

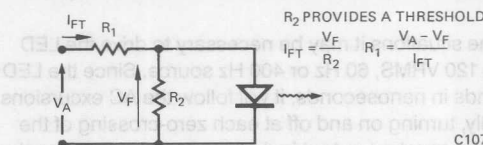


Fig. 7. LED Threshold Adjustment

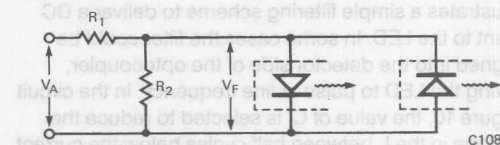


Fig. 8. Bipolar Input Selects LED

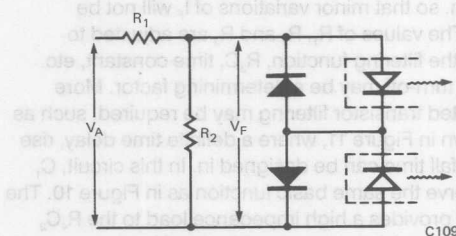


Fig. 9. High Threshold Bipolar Input

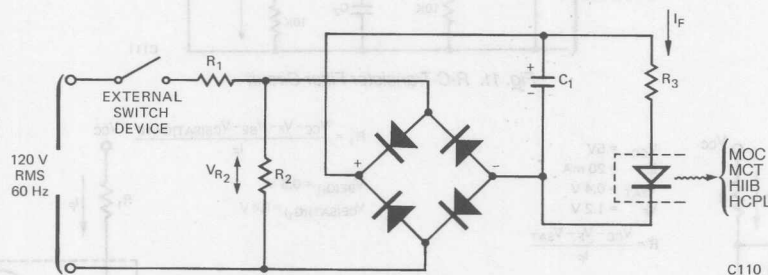


Fig. 10. AC Input to LED Drive Circuit

Another method of obtaining a high threshold for high level noise immunity is shown in Figure 9, where the LED's are in inverse series with inverse parallel diodes to conduct the opposite polarity currents. In this circuit the V_F is the total forward drop of the LED and silicon

diode in series. The resistors serve their normal threshold and current limiting functions. The silicon diodes could be replaced by LED's from other optocouplers or visible signal indicators.

In some situations it may be necessary to drive the LED from a 120 VRMS, 60 Hz or 400 Hz source. Since the LED responds in nanoseconds, it will follow the AC excursions faithfully, turning on and off at each zero-crossing of the input. If a constant output is desired from the optocoupler detector, as in AC to logic coupling, it is necessary to rectify and filter the input to the LED. The circuit of Figure 10 illustrates a simple filtering scheme to deliver a DC current to the LED. In some cases the filter could be designed into the detector side of the optocoupler, allowing the LED to pulse at line frequency. In the circuit of Figure 10, the value of C_1 is selected to reduce the variations in the I_F between half cycles below the current that is detectable by the detector portion. This condition usually means that the detector is functioning in saturation, so that minor variations of I_F will not be sensed. The values of R_1 , R_2 and R_3 are adjusted to optimize the filtering function, R_3C_1 time constant, etc. Speed of turn-off may be a determining factor. More complicated transistor filtering may be required, such as that shown in Figure 11, where a definite time delay, rise time and fall time can be designed in. In this circuit, C_1 and R_3 serve the same basic function as in Figure 10. The transistor provides a high impedance load to the R_4C_2 filter network, which, once reaching the V_F value, suddenly turns on the LED and pulls the transistor quickly into saturation. The turn-off transient consists of the discharge of C_1 through R_3 and the LED.

In logic-to-logic coupling using the optocoupler, a simple transistor drive circuit can be used as shown in Figure 12. In the normally-off situation, the LED is energized only when the transistor is in saturation. The design equations are given for calculating the value of the series current limiting resistor. With the transistor off, only minor collector leakage current will flow through the LED. If this small leakage is detectable in the optocoupler detector, the leakage can be bypassed around the LED by the addition of another resistor in parallel with the LED shown as R_1 . The value of R_1 can be large, calculated so that the leakage current develops less than threshold V_F (~ 0.8 volt) from Figure 5. The drive transistor can be the normal output current sink of a TTL or DTL integrated circuit, which will sink 16 mA at 0.2 volt nominal and up to 50 mA in saturation.

If the logic is not capable of sinking the necessary I_F , an auxiliary drive transistor can be employed to boost current capability. The circuit of Figure 13 shows how a PNP transistor is connected as an emitter follower, or common collector, to obtain current gain. When the output of the gate (G_1) is low, Q_1 is turned on and current flows through the LED. The calculation of R_1 must now include the base-emitter forward biased voltage drop, V_{BE} , as shown in the figure.

In the normally on situation of Figure 14, the transistor is required to shunt the I_F around the LED, with a V_{SAT} of less than threshold V_F . Typical switching transistors

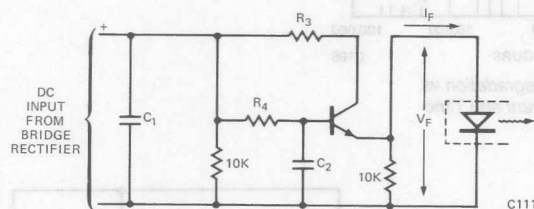


Fig. 11. R-C-Transistor Filter Circuit

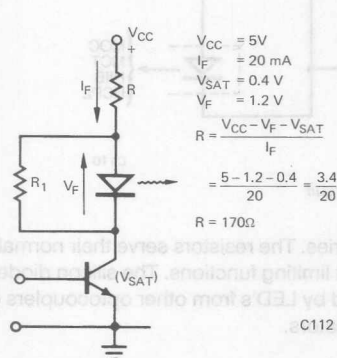


Fig. 12. Transistor Drive, Normally Off

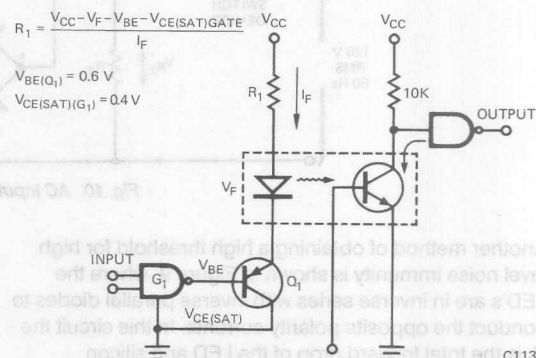


Fig. 13. Logic to LED Series Booster

have saturation voltages less than 0.4 volts at $I_C=20$ mA or less. The value of the series resistor is determined to provide the required I_F with the transistor off.

Again, if the logic cannot sink the I_F , a booster transistor can be employed as shown in Figure 15. With the output of the gate low the transistor Q_1 will be on, and the sum of V_{CE} (SAT) of G_1 and V_{BE} of Q_1 will be less than the threshold V_F of the LED. With the gate high, Q_1 is not conducting and the LED is. The value of R_1 is calculated normally, but shunt current will be greater than I_F . The normally-on or normally-off conditions are selected depending on the required function of the detector portion of the optocoupler and fail-safe operation of the circuits.

In many applications it is found necessary to pulse drive the LED to values beyond the DC ratings of the device. In these situations a "pulse" is defined as an on-off transient occurring and ending before thermal equilibrium is established between the LED, the lead frame, and the ambient. This equilibrium will normally occur within one millisecond. For a pulse width in the microsecond range, the I_F can be driven above the DC ratings, if the duty cycle is low. The chart of Figure 16

shows the relationship between the amount of overdrive, duty cycle, and pulse width. The overdrive is normalized to the I_{DC} value listed as maximum on the device data sheet. Average power dissipation is the limiting parameter at high duty cycles and short pulse widths. For longer pulse widths, the equilibrium temperature occurs at lower duty cycle values, and peak power is the limiting parameter.

For duty cycles of 1% or less the pulse becomes similar to a non-recurrent surge allowing additional ratings such as the I^2t used in rectifier diodes. Average current is used for lifetime calculation. The pulse response of the detector must be considered in choosing drive conditions.

There are situations where it is not desirable to pass all of the input current through the LED. One method to achieve this is to provide a bypass resistor as suggested in Figure 7 for threshold adjustment. This method is satisfactory where the input current is switched on and off completely, but, if the information on the current is only a small variation riding on a constant DC level, the bypass resistor also bypasses a large portion of the desired signal around the LED. Two methods can be used to retrieve the signal with little

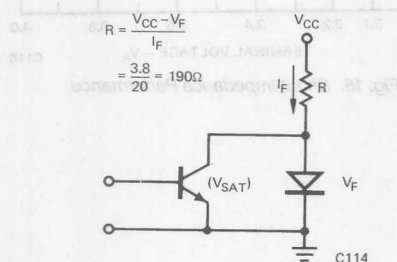


Fig. 14. Transistor Drive, Normally On

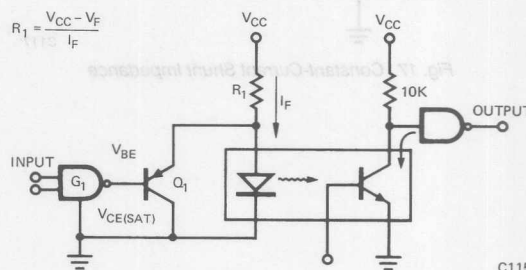


Fig. 15. Logic to LED Shunt Booster

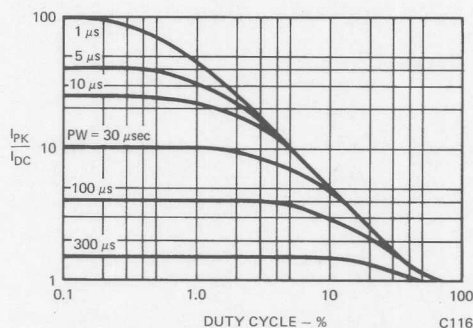


Fig. 16. Maximum Peak I_F Pulse Normalized to Max I_{DC} for Pulse Width (PW) and Duty Cycle (%)

paralleled LED circuit. The graph of Figure 18 shows the performance of this particular circuit adjusted to center on $I_L=120$ mA and a circuit node voltage of 3.4 volts. In the circuit shown the detector portions of the CNY17-1 and CNY17-4 were employed for convenience. Note that in Figure 18 most of the current variation occurs as I_F . The ratio between the DC resistance (R_D) and dynamic impedance (R_d) for the shunt is 50, which represents the signal transfer gain achieved over a fixed resistor.

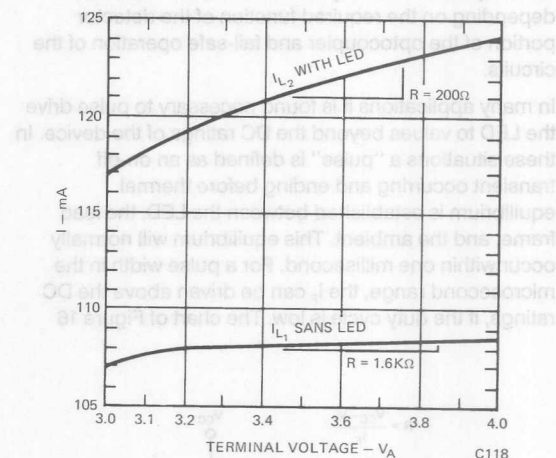


Fig. 18. Shunt Impedance Performance

AN1074

Introduction

Advancements in opto-coupling and LED technology have given us the 6N139. This unique optocoupler, having an input LED current specification at 500 microamperes, has opened some interesting design doors. Besides the obvious and much written about ability to be directly driven by CMOS circuits, the 6N139 can be considered for signal detection, transient detection, matrices and non-loading line receiving. Following are but a few circuit ideas to stimulate the designer's interest.

Signal Detection

The detection of noise, spikes or oscillations can easily and directly be detected by the input of the 6N139 as shown in the circuit of Figure 1.

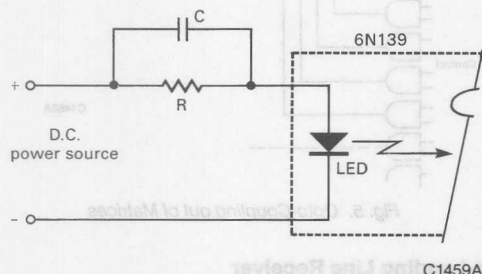


Fig. 1. 6N139 Input Circuit For Signal Detection

For the detection of undesirable signals on a D.C. power source use:

$$R = \frac{\text{Power supply voltage} - 1.5 \text{ volts}}{50 \text{ microamperes}}$$

C = To effect 500 microamperes into LED

X = Latching or non-latching output circuitry to follow

LED = Input diode of 6N139

The LED is provided with a 50 microampere forward current to charge the LED capacity to the V_f level. In

this way, the LED is not causing conduction in its output circuitry but is prepared to conduct very quickly. Any noise or oscillation on the "D.C. power source" is coupled through "C" which develops a signal across the LED. Even small unwanted signals can cause a large change in the LED forward current. Once the LED's forward current equals or exceeds 500 microamperes, the output circuitry will conduct indicating the presence of the unwanted signal.

Transient Detection

The detection of the presence or absence of waveforms can easily be detected by the circuit in Figure 2.

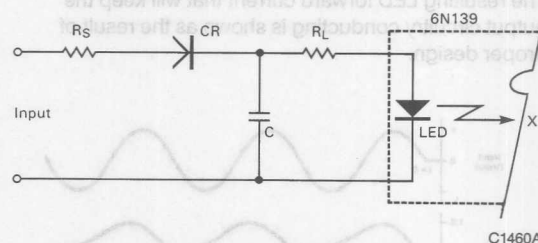


Fig. 2. Pulse or Waveform Detection Circuit

For the detection of the presence of a desired signal, pulse or waveform use:

CR = Silicon diode

$$R_L = \frac{(\text{Positive Vpk. of input}) - 2.5 \text{ volts}}{1 \text{ milliampere}}$$

$$C_{min} = \frac{\text{Pulse interval of } 1/\epsilon}{R_L}$$

$$R_{smax} = \frac{\text{Pulse width or } 1/4F}{5C}$$

X = Non-latching output circuitry to follow

LED = Input diode of 6N139

Examples:

A desired pulse train to be present is shown in Figure 3.

The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

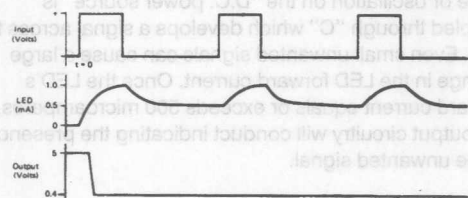


Fig. 3. Pulse Train Waveforms

A desired sine wave to be present is shown in Figure 4. The resulting LED forward current that will keep the output circuitry conducting is shown as the result of proper design.

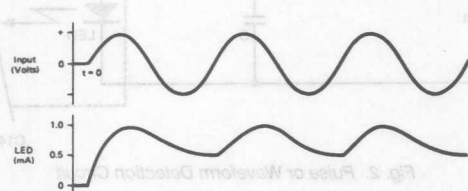


Fig. 4. Sine Wave Waveforms

Matrices Opto-Coupling

With the low input LED current advantage of the 6N139, the ability to drive matrices with but one TTL output is now possible as shown in Figure 5.

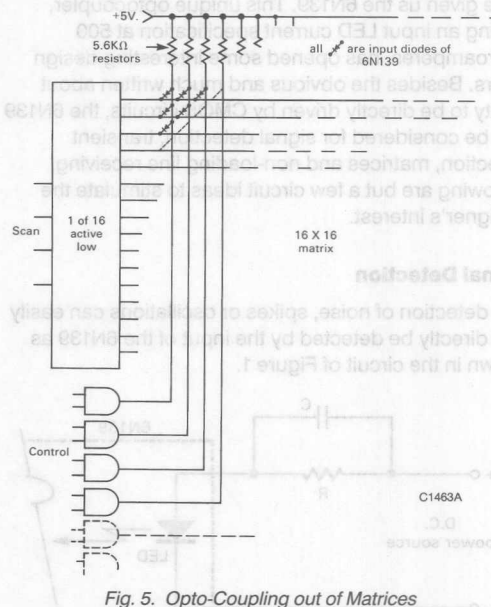


Fig. 5. Opto-Coupling out of Matrices

Non-Loading Line Receiver

For virtual non-loading, the 6N139 is compatible with the differential amplifier circuit of Figure 6.

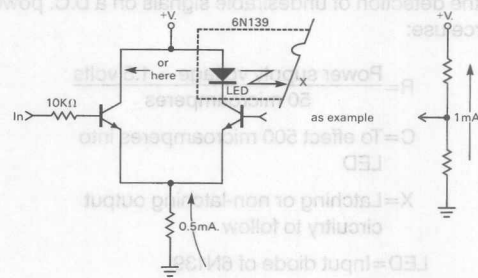


Fig. 6. Differential Amplifier Drive

For a virtual no-load optoisolator circuit use:

X=Non-latching output
circuitry to follow

LED=Input diode of 6N139

Current requirement at "in" will be less than 20 microamperes.

Example:

If "REF" is made to be +1.4 volts and the resistor common to the emitters is 1.2K Ω , the circuit will respond nicely to TTL "0" and "1" levels. That is, a "0" at "In" will cause LED current resulting in the conduction of the output circuitry. Conversely, a "1" at "In" will result in no LED current. Notice that depending upon which collector the LED is in series with it will give the option of LED current flowing with a "0" or a "1" at "In".

6N139 Output Circuitries

The following are two examples of 6N139 output circuitry. One latching (Figure 7); the other non-latching (Figure 8), but both capable of driving a TTL gate directly.

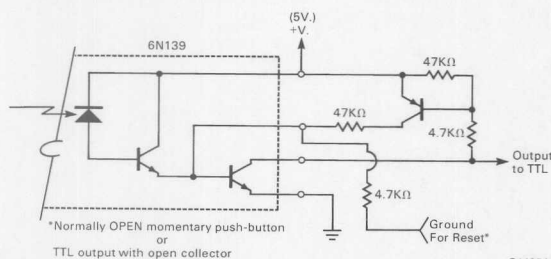


Fig. 7. Latching Output Circuit for 6N139

Referring to Figure 7 and assuming that the "RESET" has been actuated by a momentary ground and no input signal is being received, all transistors shown are non-conducting (Output high, "1"). The arrival of an input signal will cause all transistors to turn on. (Output low, "0"). The PNP transistor, being turned on by the output transistor, will in turn latch that same output transistor or until the "RESET" is again initiated.

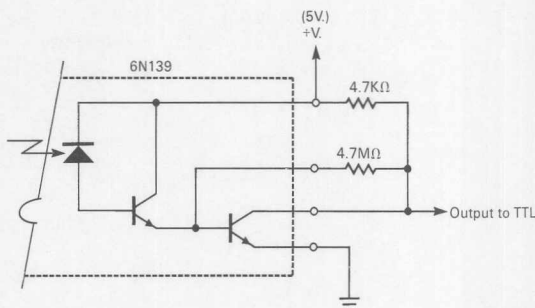


Fig. 8. Non-Latching Output Circuit For 6N139

In Figure 8, where no signal is being received, the input transistor is not conducting. The output transistor is very slightly conducting. The 4.7M Ω resistor causing this slight conduction will *not* bring the "Output" to a "0" level. The purpose of this slight conduction is to reduce the turn-on delay time. When a signal is received, both input and output transistors are turned on causing the "Output" to a logic "0" state. The 4.7M Ω resistor will now tend to reduce the output transistor's turn-off time.

If you have not looked over the 6N139 specification sheet, you may not be totally aware of the current capabilities of Quality Technologies optocouplers.

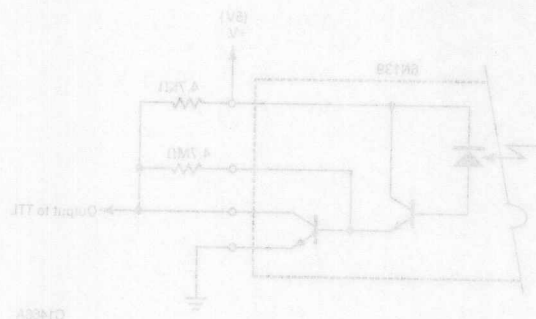


FIGURE 8

Non-Latching Output Circuit for 6N138

In Figure 8, where no signal is being received, the input transistor is not conducting. The output transistor is very slightly conducting. The 4.7MΩ resistor causes this slight conduction will not bring the "Output" to a "0". The purpose of this slight conduction is to reduce the turn-on delay time. When a signal is received, both input and output transistors are turned on causing the "Output" to a logic "0" state. The 4.7MΩ resistor will now tend to reduce the output transistor's turn-off time.

If you have not looked over the 6N138 specification sheet, you may not be totally aware of the current capabilities of Quality Technology optocouplers.

Example: If "REF" is made to be +1.4 volts and the resistor common to the emitter is 1.5KΩ, the circuit will respond nicely to TTL "0" and "1" levels. That is a "0" at "in" will cause LED current resulting in the conduction of the output circuit. Conversely a "1" at "in" will result in no LED current. Notice that depending upon which collector the LED is in series with it will give the option of LED current flowing with a "0" or a "1" at "in".

6N138 Output Circuits

The following are two examples of 6N138 output circuitry. One latching (Figure 7), the other non-latching (Figure 8), but both capable of driving a TTL gate directly.

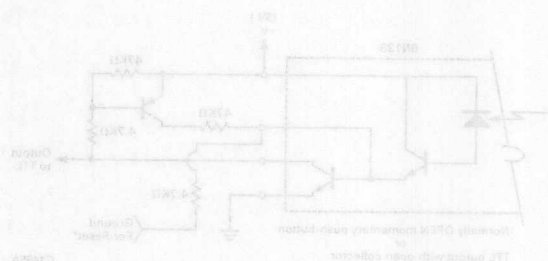


FIGURE 7

Latching Output Circuit for 6N138

Referring to Figure 7 and assuming that the "RESET" has been actuated by a momentary ground and no input signal is being received, all transistors shown are non-conducting (Output high, "1"). The arrival of an input signal will cause all transistors to turn on. (Output low "0"). The PNP transistor, being turned on by the output transistor, will in turn latch that same output transistor or until the "RESET" is again initiated.

BASIC CIRCUIT OPERATION

Consider the test circuit shown in Figure 2. Back-to-back input diodes D_1 and D_2 each conduct on every half cycle of the AC input waveform, producing 120Hz light pulses. The light output causes the photodiode to conduct, raising the potential of the input to the amplifier, and in turn driving the output NPN transistor ON. When input current is removed, light from the two LED's ceases, charge established by the photodiode current on the input amplifier leaks away, and the NPN transistor turns OFF. There are basically three operation modes: Saturated, unsaturated, and the "OFF" STATE mode.

SATURATED MODE

When input AC is above the recommended 4mA RMS minimum input current, the 120Hz photodiode pulses are sufficient to saturate the amplifier, so that the MID400 output is low at pin 6 as long as AC input signal is present, (see Figure 3).

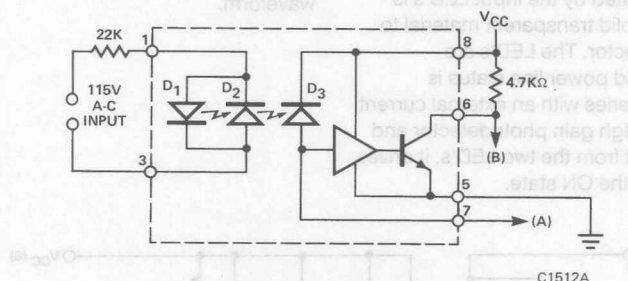


Fig. 2. Test Circuit

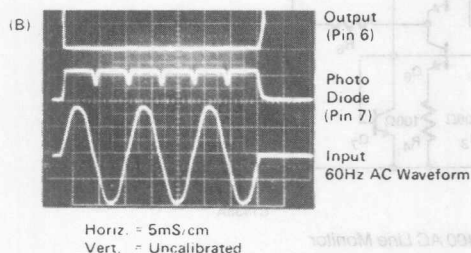


Fig. 3. Saturated Operation

NOTE: Normal specified 4mA RMS input I_F current. Output saturated (latched). The 120Hz pulses from the photodiode D_3 are above the threshold of the amplifier; therefore, the MID400 output is low anytime the AC current is present.

UNSATURATED MODE

If input current is dropped below the recommended 4mA RMS, the amplifier drops out of saturation during the zero-crossing periods of the input AC waveform and 120Hz pulses appear on MID400 output pin 6, (see Figure 4). Under these conditions the device makes an attractive, simple 120Hz clock generator that is free from most of the normal power line transients for many digital applications.

OFF-STATE MODE

When the input RMS AC input current is below 0.15mA the MID400 output will be in the high state as per specifications.

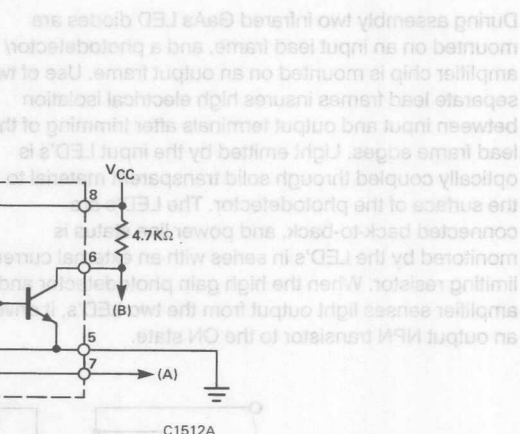


Fig. 4. Unsaturated Operation

NOTE: Below normal specified 4mA RMS input I_F current. The level of 120Hz pulses from the photodiode are now below the input threshold of the amplifier and the pulses appear on the output. The output pulse width depends on the AC input drive level.

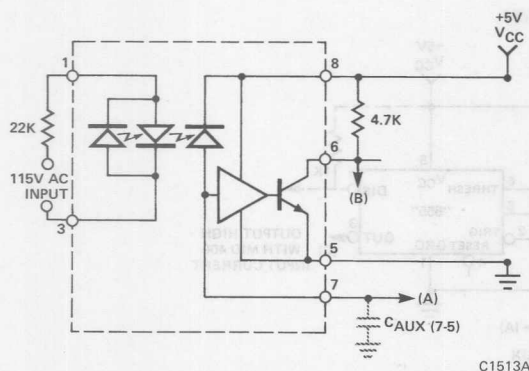


Fig. 5. Circuit with Addition of Capacitor at Pin 7

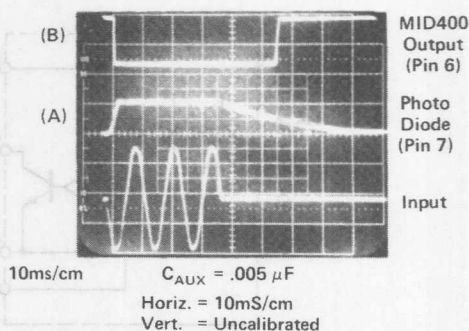


Fig. 6. Waveforms with Capacitor Added at Pin 7

OPERATION WITH AN EXTERNAL CAPACITOR

Figure 5 shows a basic delay circuit obtained by addition of an integrating capacitor C_x to the photodiode/amplifier input point pin 7. Delay at POWER ON is short, as the photodiode, when conducting, has a low impedance providing a fast charge to the capacitor. The delay when AC is removed is long, because the

capacitor discharges through various leakages of the amplifier and the photodiode. The waveforms in Figure 6 shows the capacitance on both TURN-ON and TURN-OFF delays. Figures 7 and 8 show plots of capacitance versus turn-on and turn-off time.

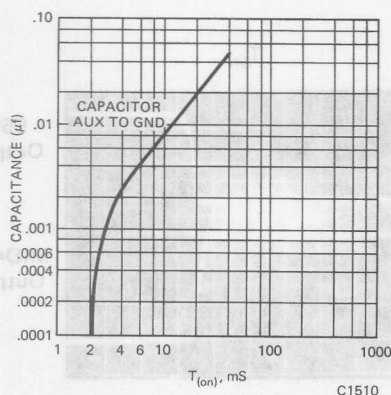


Fig. 7. Plot of Capacitance Versus Turn-on Time

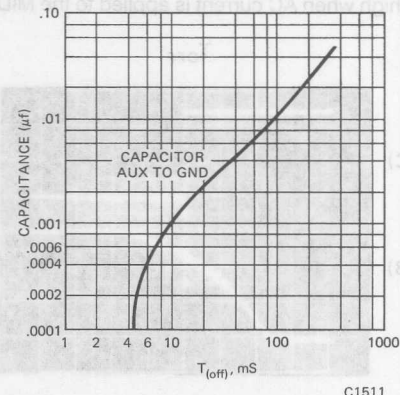


Fig. 8. Plot of Capacitance Versus Turn-off Time

MID400 INTERFACE CIRCUITS USING A 555 TIMER

Addition of a 555 Timer at the MID400 output, as shown in Figure 9, produces an interface circuit with improved drive capability and output switching times, and better

noise immunity. Figure 10 illustrates these switching time improvements.

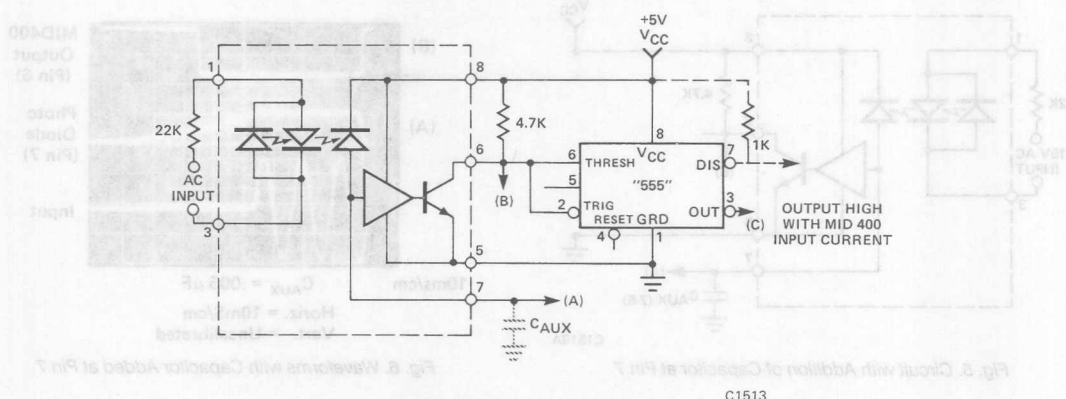


Fig. 9. Circuit with 555 Timer Added

The 555 Timer is basically being used as a SCHMITT trigger circuit with well defined input thresholds. The input HIGH state is $2/3 V_{cc}$, +5 volts in this case), and its LOW state is $1/3 V_{cc}$.

The output may be taken from either 555 pin 3 or from pin 7 discharge point with a pullup resistor. Both these pins are high when AC current is applied to the MID400.

The 555 output is capable of supplying both sink and source currents up to 200mA. One advantage of using the 555 discharge output pin is that it can be tied to another similar unit to provide the "AND" function. That is both AC inputs to both units must be present before the 555 outputs can be high.

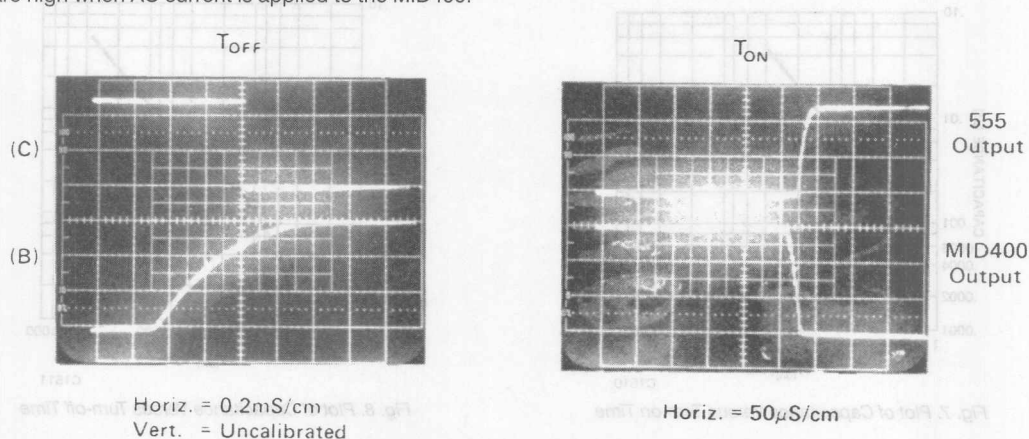


Fig. 10. Output Waveforms for T_{ON} T_{OFF} . Pin 7 Auxiliary Input Open Using the 555 Circuit (Fig. 9)

Figure 11 shows a circuit which includes a 555 Timer for shaping of waveforms. This circuit can provide an adjustable delay either at power on or power off. Delay is adjusted by the time constant of R_x and C_x . Insertion of diode D_1 across R_x provides either a fast charge and slow discharge of C_x , or a slow charge and fast discharge when diode polarity is reversed. See

waveforms in Figures 12 through 14. Because charge on capacitor is established by the output of MID400, the delay will vary according to whether MID400 is operated in saturated mode or unsaturated mode. In the unsaturated mode delay will depend upon the ratio of the pulse ON to OFF time (Duty Factor).

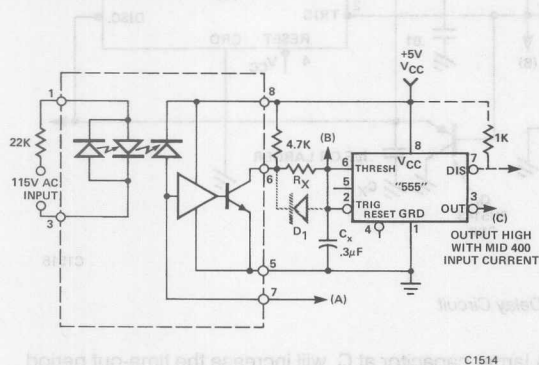


Fig. 11. Adjustable Delay Turn Off/On Circuit

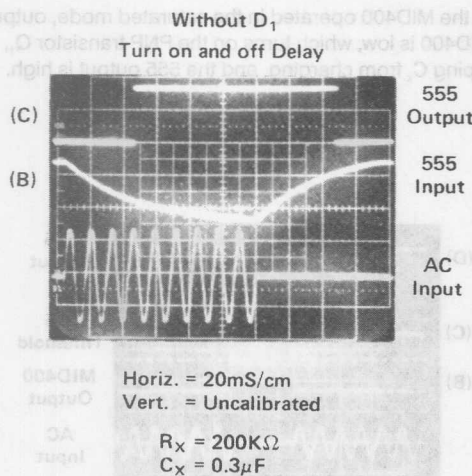


Fig. 12. Output Without D_1 Diode

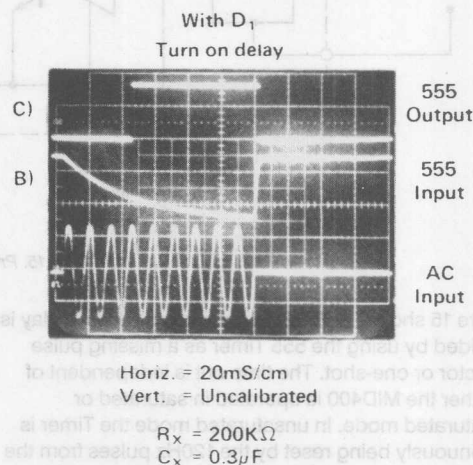


Fig. 13. Delayed Turn On, Diode D_1 Connected Opposite to Shown in Circuit Schematic

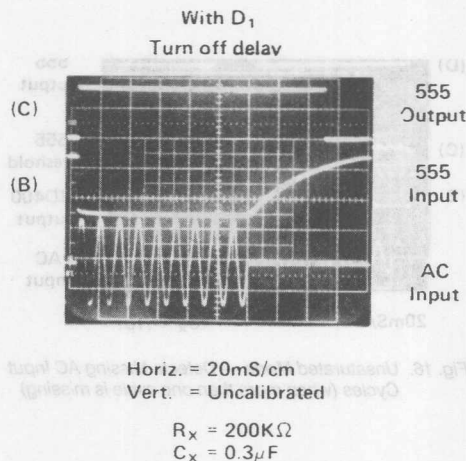


Fig. 14. Delayed Turn Off, Diode D_1 Connected As Shown in Circuit Schematic

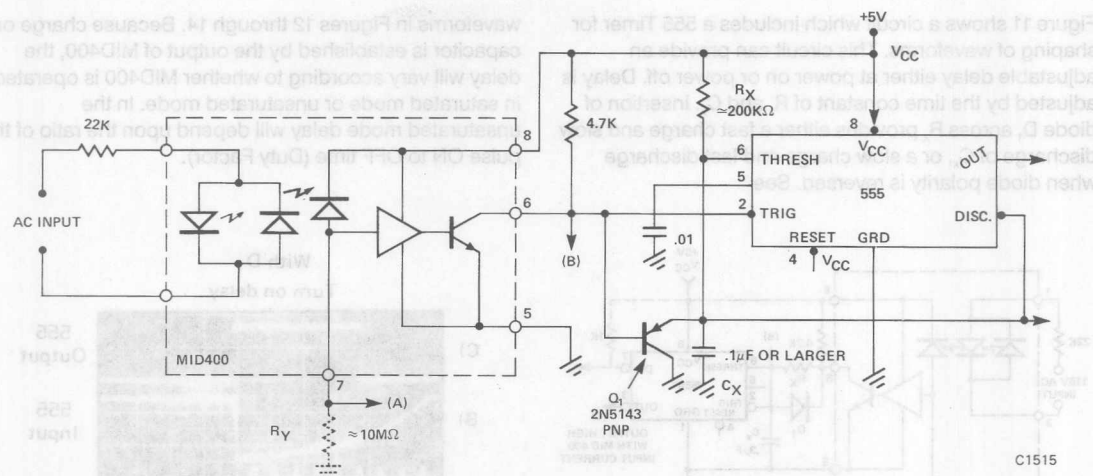


Fig. 15. Precision Delay Circuit

Figure 15 shows a precision delay circuit. Here delay is provided by using the 555 Timer as a missing pulse detector or one-shot. The time out is independent of whether the MID400 is operated in saturated or unsaturated mode. In unsaturated mode the Timer is continuously being reset by the 120Hz pulses from the MID400 and output of the 555 is high. When an AC line fails, there are no 120 Hz pulses, the 555 times out and the output then goes low. Refer to waveforms in Figure 16.

A larger capacitor at C_x will increase the time-out period of the 555 causing it not to detect the missing input cycles as shown in Figure 17.

With the MID400 operated in the saturated mode, output of MID400 is low, which turns on the PNP transistor Q_1 , stopping C_x from charging, and the 555 output is high.

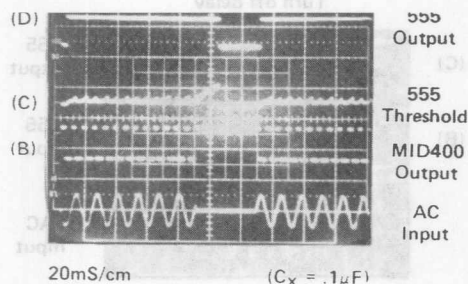


Fig. 16. Unsaturated Mode — Detects Missing AC Input Cycles (when more than one cycle is missing)

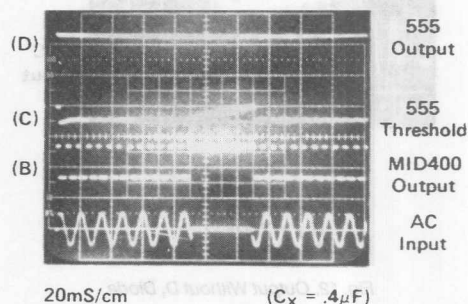


Fig. 17. Unsaturated Mode — Does NOT Detect Missing AC Input Cycles

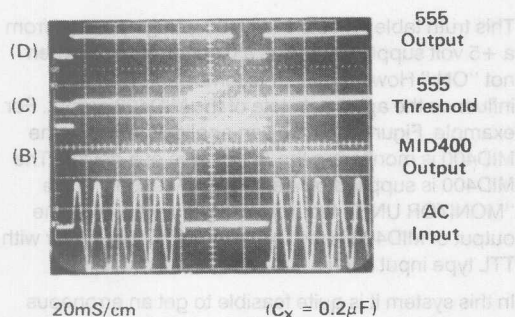


Fig. 18. Saturated Mode — Detects Missing AC Input Cycles

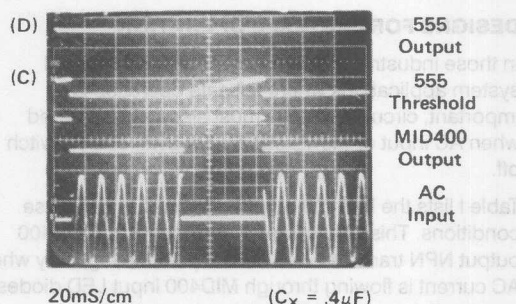


Fig. 19. Saturated Mode — Does NOT Detect Missing AC Input Cycles

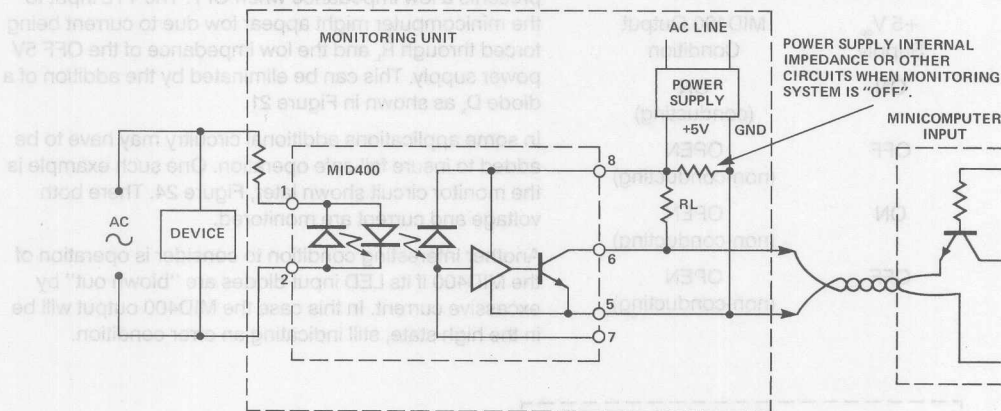


Fig. 20. Example For Fail-Safe Considerations

On AC line failure the MID400 goes high, causing Q₁ to turn off and allowing C_x to charge, so that after the required time the 555 is allowed to go LOW. Refer to the waveform in Figure 18.

By the choice of the time constant R_xC_x the circuit in either a saturated or unsaturated mode can be made to either respond or not respond to one or more AC input cycles as shown in Figures 16 through 19.

OTHER SPECIAL DESIGN CONSIDERATIONS

Special mention must be made about effects on MID400 operation caused by leakage at pin 7. To avoid problems keep impedance at 10 megohm or greater. If a capacitor is connected to pin 7, make sure it is a high quality type (such as Mylar) that exhibits very low leakage. (Even current leakage between printed circuit traces can have noticeable effects on circuit operation if the board material has poor dielectric insulation characteristics.)

DESIGNS FOR FAIL-SAFE OPERATION

In those industrial, military, computer, and medical system applications where fail-safe operation is important, circuit response must also be considered when AC input or the V_{cc} supply, (or even both), switch off.

Table I lists the MID400 output response under these conditions. This "Truth Table" shows that the MID400 output NPN transistor can be ON (conducting) only when AC current is flowing through MID400 input LED diodes and the 5V V_{cc} to the MID400 is present (ON).

Table 1. FAIL-SAFE TRUTH TABLE

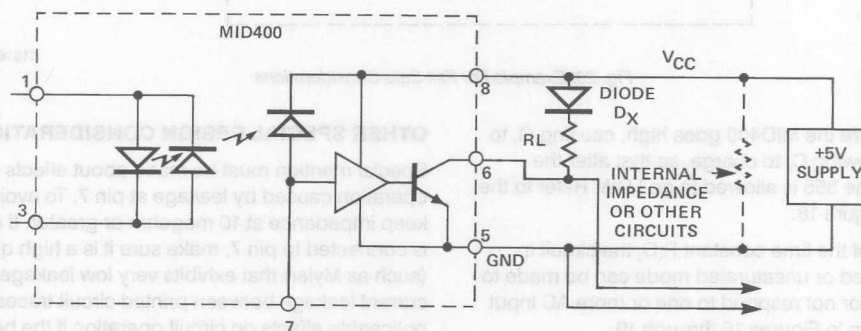
AC Line Input	+5 V_{cc} Supply	MID400 Output Condition
ON	ON	ON (conducting)
ON	OFF	OPEN (non-conducting)
OFF	ON	OPEN (non-conducting)
OFF	OFF	OPEN (non-conducting)

This truth table reflects a MID400 being operated from a +5 volt supply which has a high impedance when not "ON." However, other external factors can influence the apparent state of the MID400 output. For example, Figure 20 shows an application where the MID400 is monitoring the AC voltage of a device. The MID400 is supplied by a separate 5V supply in the "MONITOR UNIT" fed from a separate AC line. The output of MID400 is fed to a remote minicomputer with a TTL type input circuit.

In this system it is quite feasible to get an erroneous apparent output from the MID400 if R_L is 1000 ohms, or less, and the 5V power supply in the monitor system presents a low impedance when OFF. The TTL input to the minicomputer might appear low due to current being forced through R_L and the low impedance of the OFF 5V power supply. This can be eliminated by the addition of a diode D_x as shown in Figure 21.

In some applications additional circuitry may have to be added to insure fail-safe operation. One such example is the monitor circuit shown later, Figure 24. There both voltage and current are monitored.

Another interesting condition to consider is operation of the MID400 if its LED input diodes are "blown out" by excessive current. In this case the MID400 output will be in the high state, still indicating an error condition.



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Fig. 21. Diode D_x Added to Stop Reverse Current When MID400 +5V V_{cc} Line is Off

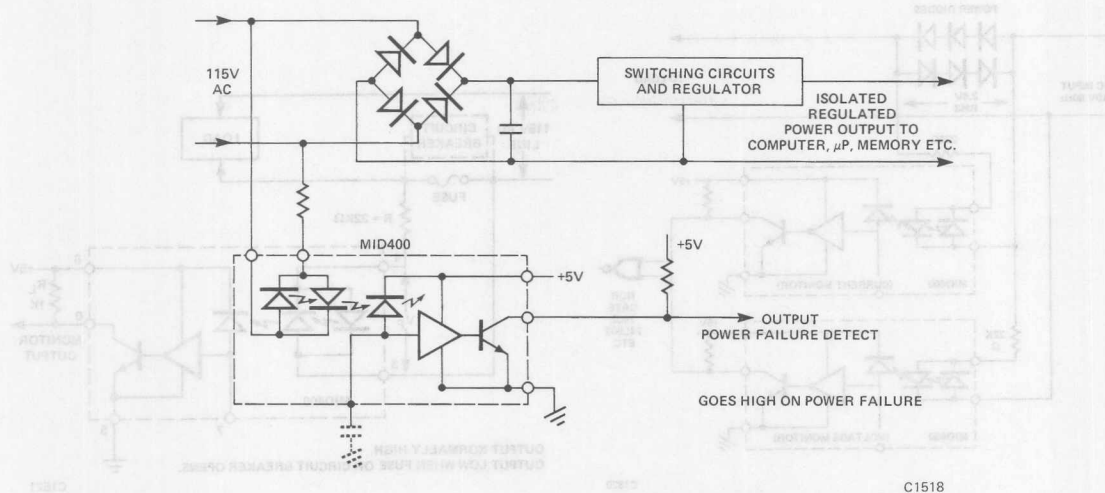


Fig. 22. Circuit for Switching Power Supply

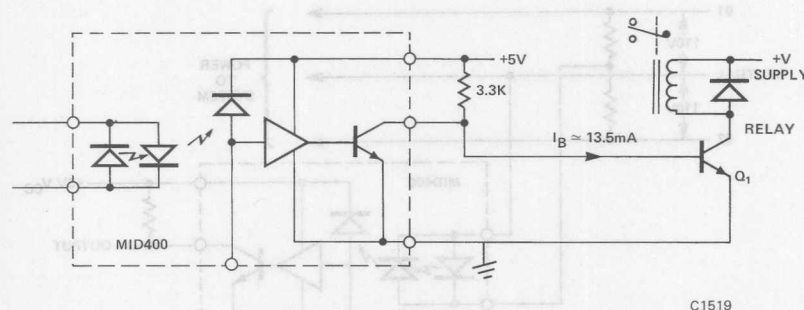


Fig. 23. Relay Interface Circuit

APPLICATION CIRCUITS

Figure 22 shows a circuit for a switching power supply to give advanced warning of power failure to computer, microprocessor, memory etc., so that an orderly power down sequence can be initiated. Such a circuit is useful because a switching power supply inherently provides power storage for a limited period of time after removal of AC input power.

Figure 23 shows a circuit that allows a relay or solenoid of almost any voltage and current rating to be controlled by the MID400. NPN transistor Q₁ must have adequate beta and voltage/current ratings for the application. Relay is energized when no AC current is flowing in the MID400 input diodes.

Figure 24 shows a circuit that uses two MID400s to monitor both voltage and current. When both voltage

and current are being supplied to the load, the output of "NOR" gate is high. If load current drops due to either open circuit or failure, the output of "NOR" gate is low.

If both voltage and current are not present the output is low. Care must be taken in overall systems design to insure fail-safe operation is achieved for all possible conditions. This topic was discussed previously in this Note.

Figure 25 shows a circuit to monitor a fuse or a circuit breaker. With this circuit consideration must be given to Fail-Safe operation. Note that if load is a very high impedance there might not be sufficient current to operate the MID400. In other words, the output of MID400 is low on open fuse or breaker. If V_{cc} to MID400 is off and fuse opens, no MID400 indication will result.

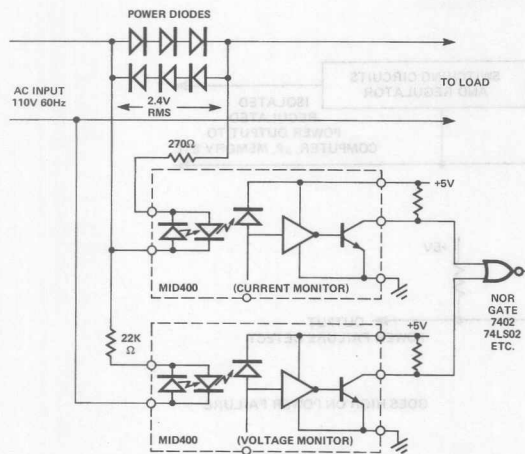


Fig. 24. AC Power Line Voltage and Current Monitor

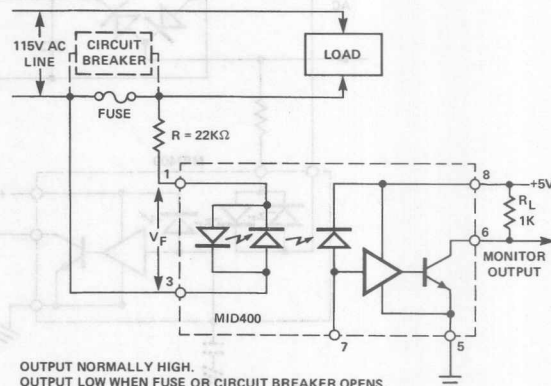
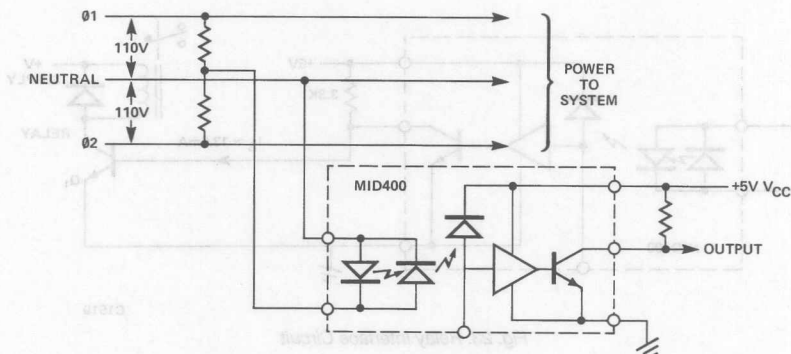
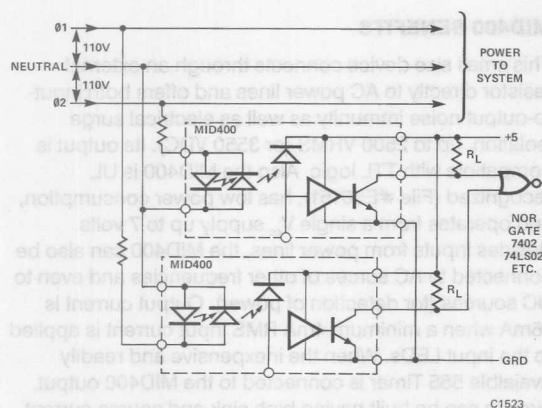


Fig. 25. Fuse or Circuit Breaker Monitor



NOTE: Circuit detects failure of either but not both phases

Fig. 26. Monitor Circuit for Two Phase Power Line



NOTE: Circuit detects failure of either or both phases
Fig. 27. Alternate Monitor Circuit for Two Phase Power Line

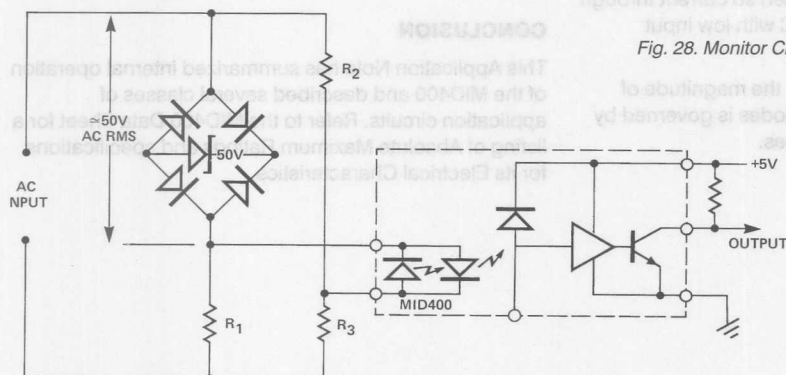


Fig. 29. AC Voltage Deviation Monitor

ADDITIONAL APPLICATION IDEAS

The following circuits are included for their intrinsic value, but may need further refining for use in a specific application.

Figure 26 shows a circuit to detect failure of either but not **both** phases on a two phase AC power line. The MID400 output goes LOW when a phase fails. Figure 27 shows a more complicated circuit that will detect failure of either or both phases on a two phase line. The NOR gate output stays HIGH so long as **both** phases are present, but switches to LOW if either or both phases fail.

Figure 28 shows a circuit to monitor a three phase line. This circuit detects a failure on a single phase, as well as all phases failing simultaneously. The output from the NOR gate is normally high when all phases are present.

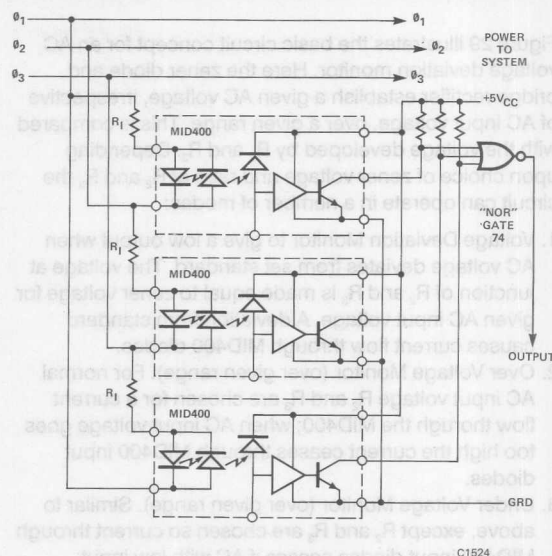


Fig. 28. Monitor Circuit for Three Phase Power Line

The input current limiting resistor R_L is chosen so the MID400s operate in saturated mode. If a phase fails, for example phase 01 goes open circuit, this effectively places MID400's #A and #B in series, causing them now to operate in non-saturated mode and produce 120Hz pulses. Therefore the output "NOR" gate outputs pulses to indicate phase failure. The output NOR gate is low when there is no power on any phase.

In some applications, for example when monitoring the power to a three phase motor, if a phase opens when the motor is running, it might run "single phase." The motor might then generate sufficient back EMF on the open phase to keep input current to MID400, and under such a condition this MID400 monitoring system is not effective.

Figure 29 illustrates the basic circuit concept for an AC voltage deviation monitor. Here the zener diode and bridge rectifier establish a given AC voltage, irrespective of AC input voltage, over a given range. This is compared with the voltage developed by R_2 and R_3 . Depending upon choice of zener voltage and ratio of R_2 and R_3 the circuit can operate in a number of modes:

1. Voltage Deviation Monitor to give a low output when AC voltage deviates from set standard. The voltage at junction of R_2 and R_3 is made equal to zener voltage for given AC input voltage. A deviation from standard causes current flow through MID400 diodes.
2. Over Voltage Monitor (over given range). For normal AC input voltage R_2 and R_3 are chosen for a current flow through the MID400; when AC input voltage goes too high the current ceases through MID400 input diodes.
3. Under Voltage Monitor (over given range). Similar to above, except R_2 and R_3 are chosen so current through MID400 input diodes ceases if AC with low input voltage is too low.

It should be noted that in this circuit the magnitude of current through the MID400 input diodes is governed by choice of R_1 , R_2 , and R_3 resistor values.

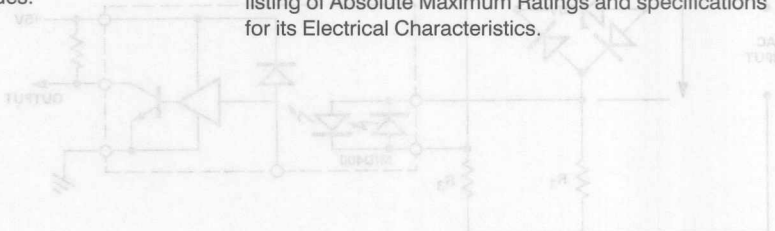


Fig. 29 AC Voltage Deviation Monitor

MID400 BENEFITS

This small size device connects through an external resistor directly to AC power lines and offers both input-to-output noise immunity as well as electrical surge isolation, up to 2500 VRMS (or 3550 VDC). Its output is compatible with TTL logic. Also the MID400 is UL recognized (File #E50151), has low power consumption, and operates from a single V_{cc} supply up to 7 volts. Besides inputs from power lines, the MID400 can also be connected to AC surces of other frequencies and even to DC sources (for detection of power). Output current is 16mA when a minimum 4mA RMS input current is applied to the input LEDs. When the inexpensive and readily available 555 Timer is connected to the MID400 output, circuits can be built having high sink and source current drive capabilities. These simple circuits can also be designed for a wide range of adjustable delay, and with rise and fall times compatible with TTL computer circuits.

CONCLUSION

This Application Note has summarized internal operation of the MID400 and described several classes of application circuits. Refer to the MID400 Data Sheet for a listing of Absolute Maximum Ratings and specifications for its Electrical Characteristics.

ADDITIONAL APPLICATION IDEAS

The following circuits are included for their intrinsic value, but may need further refining for use in a specific application.

Figure 28 shows a circuit to detect failure of either but not both phases on a two phase AC power line. The MID400 output goes LOW when a phase fails. Figure 27 shows a more complicated circuit that will detect failure of either or both phases on a two phase line. The NOR gate output stays HIGH as long as both phases are present, but switches to LOW if either or both phases fail.

Figure 26 shows a circuit to monitor a three phase line. This circuit detects a failure on a single phase, as well as all phases failing simultaneously. The output from the NOR gate is normally high when all phases are present.



AN3000

INTRODUCTION

Since the introduction of the optically coupled isolator, digital design engineers have struggled with the problem of achieving logic-in to logic-out compatibility over temperature, minimizing the effects of LED degradation, and obtaining high speed operation. Typically this problem is approached by selecting input/output resistors, and often by trial and error.

This guesswork type of interfacing is now a thing of the past. Enter the new OPTOLOGIC™ family of logic-to-logic compatible, optically coupled isolators. This easy to use logic element offers LSTTL-in to TTL-out or LSTTL-in to CMOS-out. The device eliminates the resistor selection and features guaranteed DC parameters over temperature.

This ease of design-in and operation is made possible through use of an input amplifier that provides the interface between the driving LSTTL gate and the LED emitter. The output circuitry consists of a multistage high speed amplifier available with either a totem pole or open collector output. The input amplifier, LED, and output amplifier are assembled in an industry standard six-pin package.

The Optologic devices not only provide the isolated logic-to-logic interface function, but due to many unique features of the input amplifier, offer solutions for high speed data communications and precise DC level sensing. These applications, and the operation of the Optologic interface gate, will be discussed in this application note.

OPTOLOGIC OPERATION

Functionally the Optologic gate consists of an input amplifier, high speed GaAsP/GaAs LED emitter, and an output amplifier. Figure 1 illustrates the block diagram of the LSTTL to TTL logic gate.

The input network is a hybrid assembly of a silicon IC amplifier and LED emitter. The input functionally consists of four elements: 1) open emitter input with Schottky diode clamp, 2) differential comparator, 3) voltage reference, and 4) current steering LED driver.

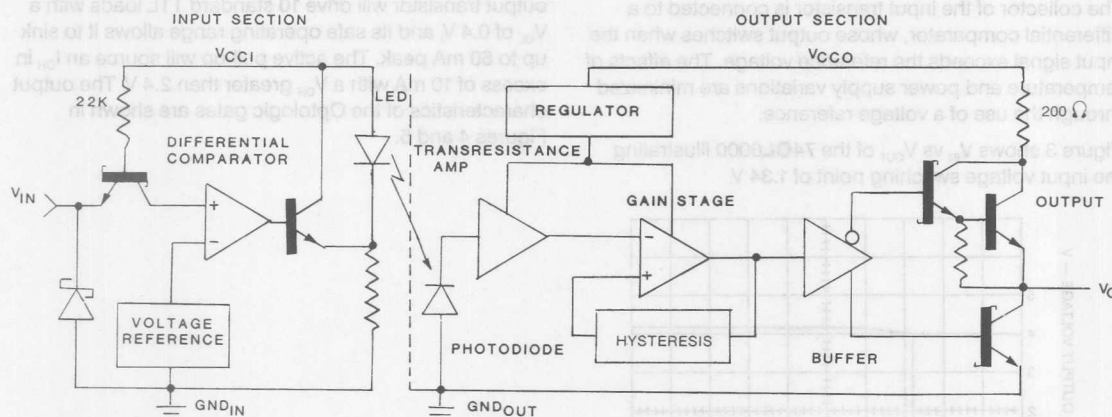


Fig. 1. 74OL6000 Block Diagram

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The input of the IC is very similar to standard bipolar logic. It consists of a Schottky clamp diode connected between the emitter of an NPN transistor and ground. The input sources input current over the nominal LSTTL logic levels. Figure 2 shows the typical input current/voltage characteristics. The input offers a 20K ohm input resistance between -0.5 to 3.0 V. The input resistance drops to 7.5 K from 3.0 to 3.4 V, while between 3.4 to 7 V the resistance is greater than 1 megohm. Input voltages more negative than 0.5 V activate the Schottky diode clamp.

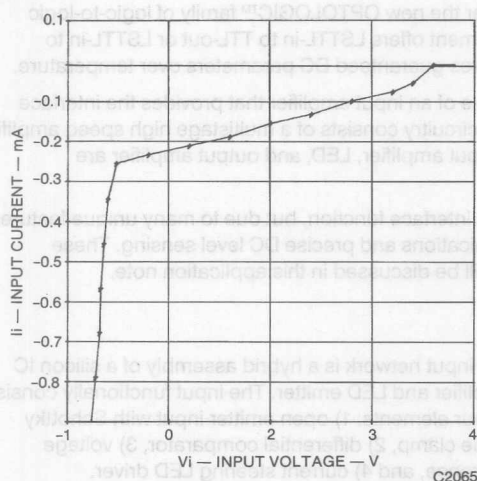


Fig. 2. Input Current vs. Input Voltage

The collector of the input transistor is connected to a differential comparator, whose output switches when the input signal exceeds the reference voltage. The effects of temperature and power supply variations are minimized through the use of a voltage reference.

Figure 3 shows V_{IN} vs V_{OUT} of the 74OL6000 illustrating the input voltage switching point of 1.34 V.

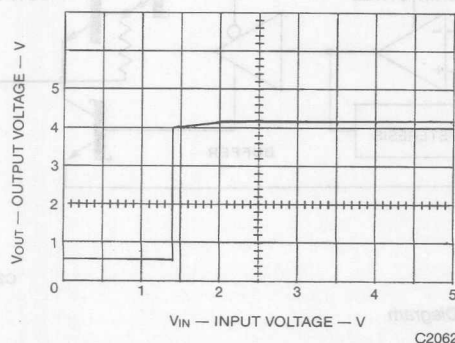


Fig. 3. 74OL6000

The output of the comparator controls a current steering LED driver. The LED is enabled when the transistor is OFF. When the transistor is driven into saturation, it steers the current away from the LED by dropping the LED voltage below its 1.5 V conduction threshold. This technique of driving has the advantage of pre-biasing the LED, thus minimizing the switching speed reduction caused by the diode junction capacitance. It has the added advantage of greatly reducing power supply noise.

The output IC consists of seven functional circuits. These include: 1) PN photodiode, 2) transresistance amplifier, 3) differential gain stage, 4) hysteresis loop, 5) buffer amplifier, 6) output stage, and 7) voltage regulator.

The optical flux developed by the LED emitter is converted to an electrical current by a reversed biased PN photodiode. This photocurrent is amplified and converted to a voltage by a transresistance gain stage. This stage is connected to the inverting input of a differential amplifier, while the hysteresis network is connected to the non-inverting input. The output of this amplifier drives a buffer that provides the level shifts and signal splitting needed to drive the totem pole output stage. Power supply noise is rejected through the use of a voltage regulator that powers the transresistance amplifier and the differential gain stage.

The output of the amplifier is offered as either an open collector (74OL6010/11) or a totem pole (74OL6000/01). The open collector output is designed to interface with CMOS logic, with a supply voltage up to 15 volts. The output transistor will drive 10 standard TTL loads with a V_{OL} of 0.4 V, and its safe operating range allows it to sink up to 60 mA peak. The active pull-up will source an I_{OH} in excess of 10 mA with a V_{OH} greater than 2.4 V. The output characteristics of the Optologic gates are shown in Figures 4 and 5.

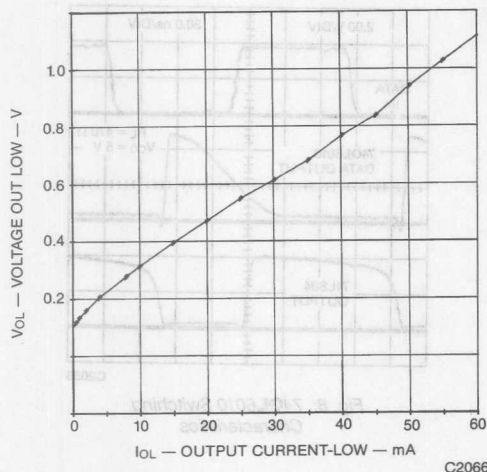


Fig. 4. 74OL6000 V_{OL} vs I_{OL}

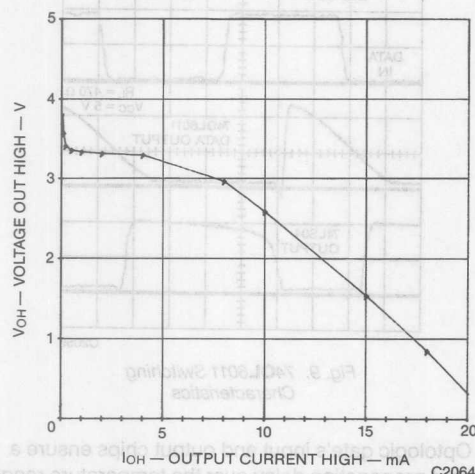


Fig. 5. 74OL6000 V_{OH} vs I_{OH}

The effects of common mode transients and other noise sources on the output amplifier are reduced by an optically transparent, electrically conductive noise shield, as well as by amplifier hysteresis. The shield shunts the noise away from the input stage and channels it to logic ground. The amplifier hysteresis eliminates false output pulses caused by a slowly varying input signal, or power supply noise found on the input network of the Optologic gate.

These three chips are assembled in an industry standard six-pin dual-in-line package. Quality Technologies uses its patented over/under split lead-frame assembly process. This process has proven to be very reliable given environments typically found in industrial interface applications. This package is recognized under

Underwriters Laboratories File E#50151, and with a withstand test voltage of 2500 V_{RMS} , guarantees continuous operation at 440 VAC.

SWITCHING OPERATION

The Optologic optocoupler was designed to interface directly with LSTTL at the input and either TTL or CMOS at the output. In addition, the switching levels are identical to the standards established for each of these logic families.

There are four Optologic devices currently available. Two of these devices are LSTTL to TTL compatible. The 74OL6000 is a logic buffer and the 74OL6001 is an inverter logic. LSTTL to CMOS is provided by the 74OL6010 buffer and the 74OL6011 inverter. The switching operation is shown below.

DEVICE	INPUT	LED	OUTPUT
74OL6000	HIGH LOW	OFF ON	HIGH LOW
74OL6001	HIGH LOW	ON OFF	LOW HIGH
74OL6010	HIGH LOW	OFF ON	OFF ON
74OL6011	HIGH LOW	ON OFF	ON OFF

The preceding table indicates that the Optologic gate is effectively two cascaded logic gates. The first is the input network and the second the output. Both the totem pole and open collector output amplifier function as inverters. Thus, when the LED is ON, the output will be a logic low state. Therefore, in order to create an Optologic buffer (74OL6000, 74OL6010), the input amplifier must function as an inverter for controlling the LED emitter. The Optologic inverter gates (74OL6001, 74OL6011) use a non-inverting input amplifier.

One will note that the output chip is always HIGH (OFF) when the LED is OFF, and the output is forced LOW (ON) when the LED is ON. Thus, the Optologic input has a switching threshold of 1.34 V.

The operational sequence of LED and input/output chips will give the designer insight when combinations of inverters and buffers are used in parallel data transfer applications. In these types of applications, the rate of data transfer is greatly affected by the propagation delay difference between the slowest to fastest Optologic gate. The propagation delay is the sum of the delays of the input chip, LED, and output amplifier. The typical delay times for the 74OL6000/01 are 65ns, with rise times of 45ns and fall times of 5ns. The rise and fall time difference is the result of the operation of the output amplifier. The typical switching characteristics of the 74OL6000/01 are shown in Figures 6 and 7. When output edge detection is used, the fastest response will be obtained when the falling edge (H-L) is sensed. This is true for both the inverter and buffer Optologic gates.

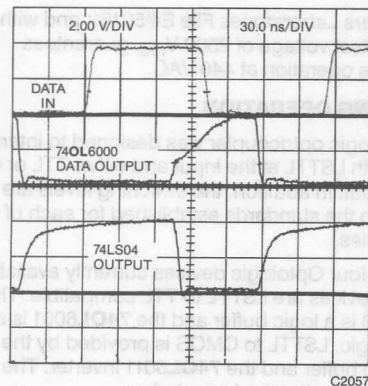


Fig. 6. 74OL6000 Switching Characteristics

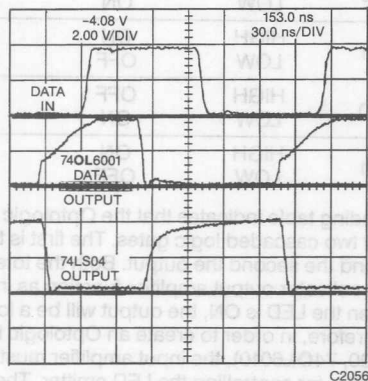


Fig. 7. 74OL6001 Switching Characteristics

The CMOS compatible output family (74OL6010/11) satisfies the V_{OH} by using an open collector transistor and an external pull-up resistor. The high to low propagation delay and fall time is very similar to the 74OL6000/01 Optologic gates. The low to high propagation delay and rise time is greatly influenced by the value of the pull-up resistor. When a 470 ohm pull-up resistor is used, the typical propagation delay for low to high is 100ns. The typical switching characteristics of the 74OL6010/11 are shown in Figures 8 and 9.

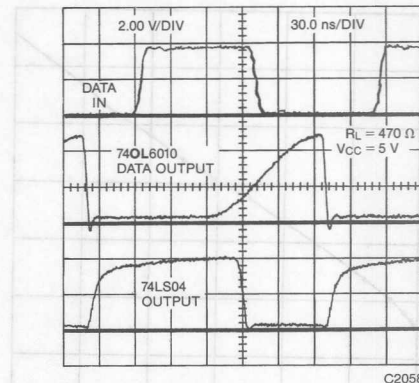


Fig. 8. 74OL6010 Switching Characteristics

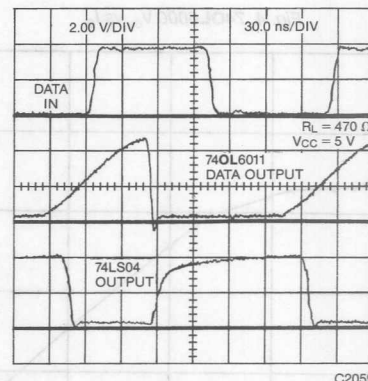


Fig. 9. 74OL6011 Switching Characteristics

The Optologic gate's input and output chips ensure a constant propagation delay over the temperature range of -40°C to 85°C . This consistency is shown in Figures 10 and 11.

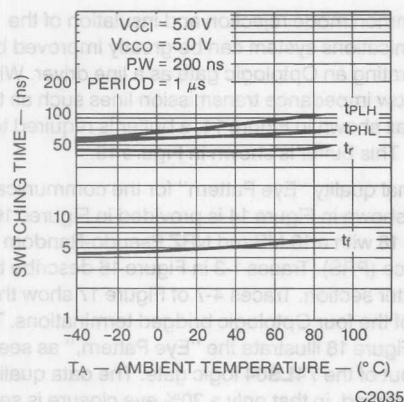


Fig. 10. 74OL6000/01
Switching Times vs.
Ambient Temperature

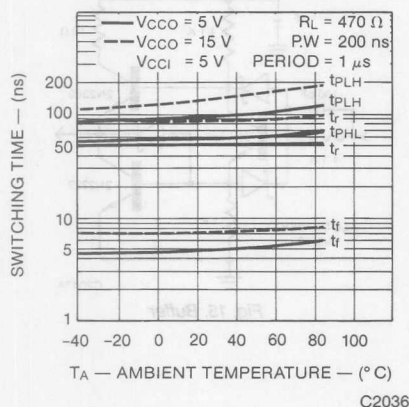


Fig. 11. 74OL6010/11
Switching Times vs.
Ambient Temperature

OPERATIONAL CONSIDERATIONS

The Optologic gates have eliminated the need to perform a worst case analysis for logic family compatability and switching speed. Operational performance degradation is greatly minimized through the optimal selection of the LED emitter and output amplifier. These features make the Optologic gates the easiest optocouplers to use for logic-to-logic interfacing.

OPERATIONAL CONSIDERATIONS

The consistent performance of the Optologic gates will be obtained if the designer ensures that package power dissipation and operational supply voltage does not exceed their absolute maximum ratings. The 74OL6000/01 were designed to operate from standard

4.5 to 5.5 volt supplies and, under these conditions, the devices will operate successfully over a -40°C to 85°C range. The 74OL6010/11 output amplifier will operate from a 15V supply over a temperature range of -40°C to 55°C , however, the output amplifier power supply voltage must be derated at a rate of $-0.27\text{V}/^{\circ}\text{C}$ above an operational temperature of 55°C . This function is shown graphically in Figure 12.

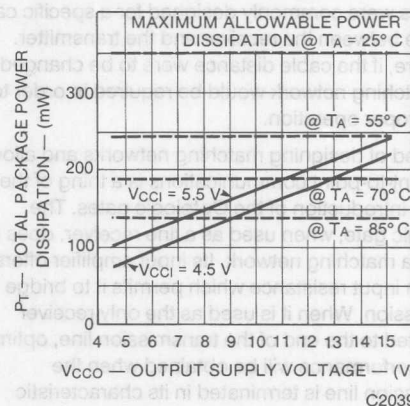


Fig. 12. Power Dissipation vs.
Ambient Temperature

Operational stability is optimized when low impedance V_{CC} and V_{DD} supplies are used to power the Optologic gates. This can be ensured by the common practice of including $0.1 \mu\text{F}$ bypass capacitors for the input and output amplifier supplies. These capacitors are placed immediately next to the V_{CC} and ground connections of the input and output amplifier. These capacitors minimize output ringing and improve the power supply noise rejection. A suggested printed circuit board layout is shown in Figure 13.

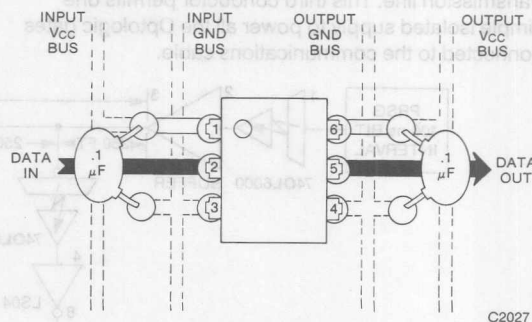


Fig. 13. Suggested PCB Lay-out

C2027

DATA COMMUNICATIONS INTERFACING

The common LED input/phototransistor output and high speed logic compatible output have found their way into point-to-point (simplex) data communications applications. When used as a line receiver the designer was required to design a matching network to provide the minimum reflection caused by the non-linear input impedance of the light emitting diode. These matching networks were commonly designed for a specific cable distance between the receiver and the transmitter. Therefore, if the cable distance were to be changed, a new matching network would be required in order to effect proper operation.

This need of designing matching networks and allowing only point-to-point communications is a thing of the past with the introduction of the Optologic gates. The Optologic gate, when used as a line receiver, does not require a matching network. Its input amplifier offers a 22Kohm input resistance which permits it to bridge the transmission. When it is used as the only receiver connected to the end of the transmission line, optimum speed performance will be obtained when the transmission line is terminated in its characteristic impedance (Z_0).

When multiple data taps are required, all the designer need do is bridge the Optologic gate across the transmission line at the desired cable length. Figure 14 illustrates a simplex multi-drop (tap) data communications system that has incorporated four 74OL6001 gates as receivers, evenly spaced along a 1000 foot, 75 ohms co-axial transmission line. The cable used in this example is a Times Fiber & Cable Model RG59/U Series 2000. This cable includes a third insulated conductor that is used as the V_{CC} supply source for the input amplifier of the Optologic gates connected to the transmission line. This third conductor permits one simple isolated supply to power all the Optologic gates connected to the communications cable.

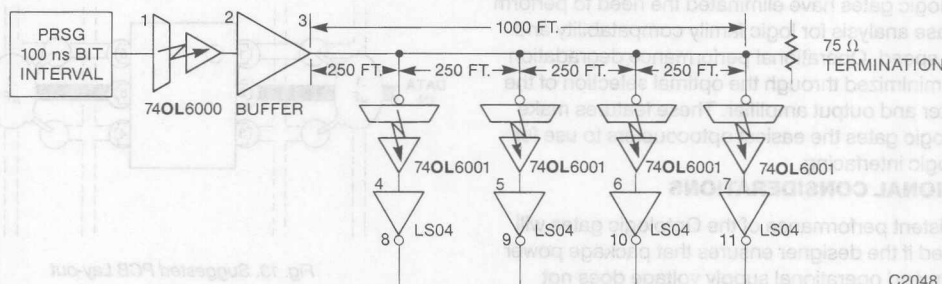


Fig. 14. Simplex Multi-drop Data Communications System

The common mode rejection and insulation of the communications system can be greatly improved by incorporating an Optologic gate as a line driver. When driving low impedance transmission lines such as the 75 ohm coax shown in Figure 14, a buffer is required to drive the line. This buffer is shown in Figure 15.

The signal quality "Eye Pattern" for the communications system shown in Figure 14 is provided in Figures 16 through 18 with a 10 MBaud NRZ Pseudo-Random Sequence (PRS). Traces 1-3 in Figure 16 describe the transmitter section. Traces 4-7 of Figure 17 show the output of the four Optologic bridged terminations. Traces 8-11 in Figure 18 illustrate the "Eye Pattern," as seen at the output of the 74LS04 logic gate. The data quality is well preserved, in that only a 30% eye closure is seen at the receiver located 1000 feet from the transmitter.

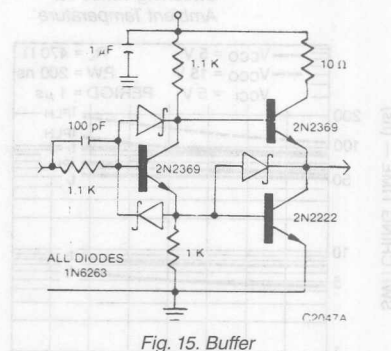


Fig. 15. Buffer

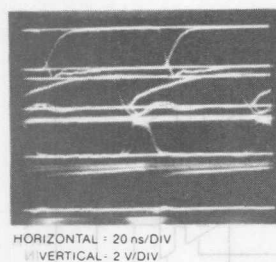


Fig. 16.

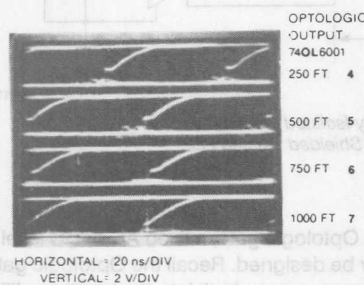


Fig. 17.

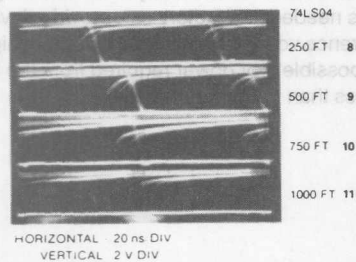


Fig. 18.

Through the use of the tri-state line driver, shown in Figure 19, a half duplex multi-drop communications system can be configured. This is done by adding this driver at each of the tap positions shown in Figure 14. This system provides the most common data communications configuration of high speed bi-directional communications, with the added features of vastly improved common mode transient rejection and insulation when compared to a common integrated line receiver.

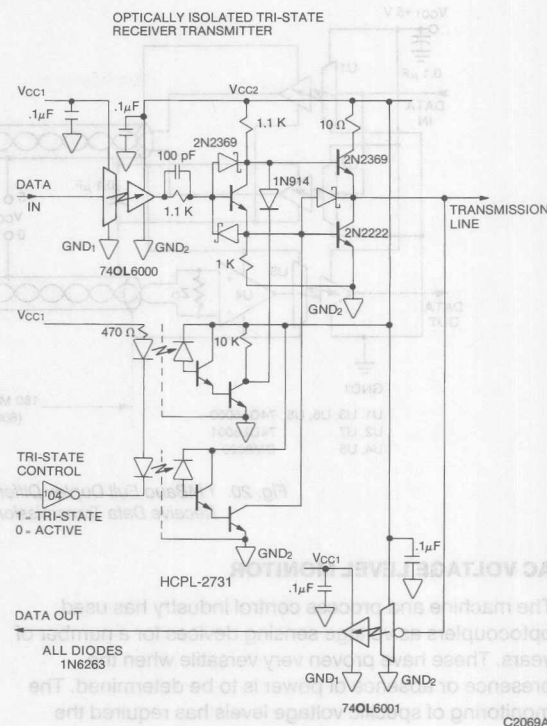


Fig. 19.

When high differential and common mode rejection are required, the differentially driven and received communications topology is considered. Figure 20 shows a full duplex point-to-point communications system that is implemented with twisted pair shielded cable. Given the higher impedance of this type of cable, it is possible for the Optologic gates to drive the line directly. Here, a 74OL6000 and 74OL6001 are used in a push-pull mode to differentially drive the line. The receiving end of the line is simply terminated in Z_0 . Bridging this termination is a DM8820 differential line receiver that is connected to the 74OL6000 Optologic gate. Power for the line receiver and the Optologic gate is derived from two insulated shields of the twisted pair cable. This system offers a data rate in excess of 1 MBaud NRZ at a distance of 600 feet.

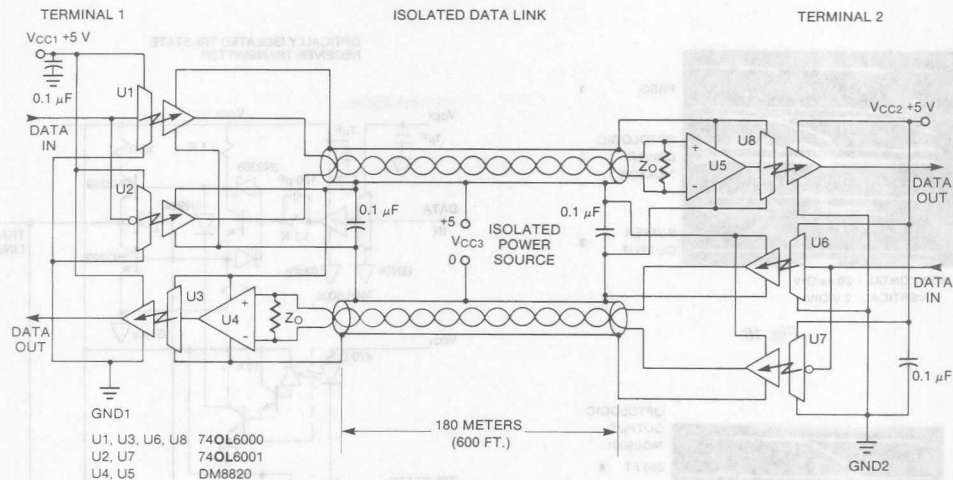


Fig. 20. 1 Mbaud Full Duplex Differential Optically Isolated Transmit and Receive Data Transmission System with Shielded Twisted Pair.

AC VOLTAGE LEVEL MONITOR

The machine and process control industry has used optocouplers as voltage sensing devices for a number of years. These have proven very versatile when the presence or absence of power is to be determined. The monitoring of specific voltage levels has required the designer to commonly use selected couplers that have guaranteed gain at a specific LED drive current. Once armed with this specification, a resistor divider network is designed that will support 1 to 10 mA required by the LED. As the line voltage threshold increases, the power dissipation in the passive divider network can approach 2 watts.

Using the Optologic gate, a fixed AC or DC level monitor can easily be designed. Recall the Optologic gate has a fixed reference source built into the input amplifier. The stability and consistency of this reference source allows the designer to construct a level detector using standard product that will offer an accuracy of $\pm 15\%$. If higher accuracy is needed, the factory can provide devices with tighter reference voltage tolerance. Not only is high accuracy possible, but power required from the line is typically less than 0.2 W.

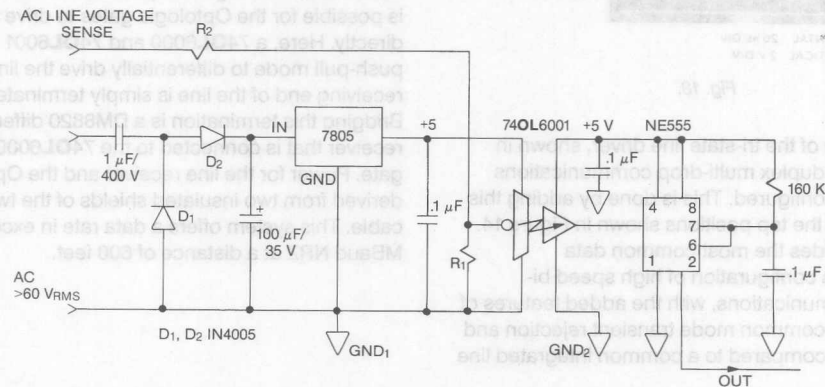


Fig. 21. Optologic Voltage Line Monitor and Power Supply

The most significant feature of the Optologic, in this application, is the small amount of current that is required to flow in the voltage divider. Under worst case design considerations, this sensing current will not exceed 500 μ A. This low current permits the use of .25 W or smaller precision resistors, thus allowing even greater monitor accuracy.

For example, when sensing a voltage of 110 VAC, the power dissipated in the divider network is only 45mW.

Figure 21 shows a typical AC Line Monitor circuit. The threshold is determined by selecting the value of R1 and R2. Best accuracy is achieved when R1 is equal to or less than 2.2Kohm. Once R1 is selected, the value of R2 can be determined with the following equation.

$$R2 = \frac{R1 R_N (V_{th} - V_{ref})}{V_{ref}(R_N + R1) - R1V}$$

Where

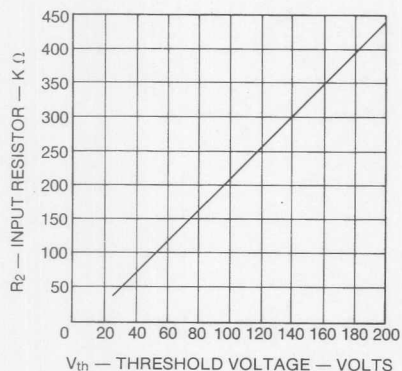
V_{th} = Selected AC or DC switching level

V_{ref} = 1.34V

R_N = 22Kohm

V = 4.3V

This equation has been solved graphically in Figure 22.

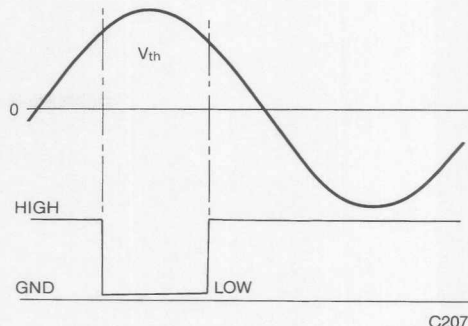


C2072

Fig. 22. Input Resistor vs. Threshold Voltage

The monitor circuit shown in Figure 21 consists of three elements. The first is an Optologic power supply, the second is the voltage divider, and the third is the retriggerable one-shot.

The power supply consists of a capacitor voltage divider and 5V regulator. A capacitor divider was used to minimize the power consumption from the AC line. This power supply will provide over 15 mA when the line voltage exceeds 60V RMS.



C2071

Fig. 23. 74OL0001 AC Level Detection Waveform

The voltage divider (R1, R2) sets the monitor threshold point of the sensor. R1 is used as an Optologic input pull-down, thus, as the input voltage rises, it forces current through R1 which raises its voltage up to the Vref of the Optologic input. Once the reference voltage is exceeded, the output of the Optologic will change state. Figure 23 illustrates the relationship of the input voltage to the 74OL6001 output. It can be seen that the output is a series of pulses, whose width is determined by the duration that the input waveform exceeds the voltage threshold.

The final section of the sensor consists of a retriggerable one-shot, constructed with an NE555 timer. This one-shot is included to convert the pulse train into a constant logic level. For best stability, a time constant of 1-1/4 cycles was selected. When a 60Hz power main is to be monitored, this becomes a time constant of 18ms. Thus, as the input voltage exceeds the monitor threshold, the output of the 74OL6001 changes from high to low, thus triggering the NE555 timer. Once triggered, the NE555 outputs a logic high and will stay high as long as it is triggered every 16ms.

CONCLUSION

The Optologic family of TTL and CMOS compatible devices is a new and easy-to-use optically coupled logic circuit element. This Application Note has provided but few of many new uses for this versatile device. Not only does this device provide high noise immunity and level shifting for logic-to-logic interfaces, it also has numerous applications in data communications and industrial control systems.

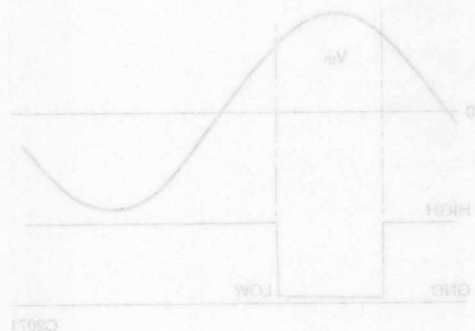


Fig. 23. 74OL6001 AC Level Detection Waveform

The voltage divider (R1, R2) sets the monitor threshold point of the sensor. R1 is used as an Optologic input pull-down, thus, as the input voltage rises, it forces current through R1 which raises its voltage up to the V_{th} of the Optologic input. Once the reference voltage is exceeded, the output of the Optologic will change state. Figure 23 illustrates the relationship of the input voltage to the 74OL6001 output. It can be seen that the output is a series of pulses, whose width is determined by the duration that the input waveform exceeds the voltage threshold.

The first section of the sensor consists of a retriggerable one-shot, constructed with an NE555 timer. This one-shot is included to convert the pulse train into a constant logic level. For best stability, a time constant of 1-1A cycles was selected. When a 60Hz power main is to be monitored, this becomes a time constant of 16ms. Thus, as the input voltage exceeds the monitor threshold, the output of the 74OL6001 changes from high to low, thus triggering the NE555 timer. Once triggered, the NE555 outputs a logic high and will stay high as long as it is triggered every 16ms.

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The Optologic family of TTL and CMOS compatible devices is a new and easy-to-use optically coupled logic circuit element. This Application Note has provided but a few of many new uses for this versatile device. Not only does this device provide high noise immunity and level shifting for logic-to-logic interfaces, it also has numerous applications in data communications and industrial control systems.

The most significant feature of the Optologic, in this application, is the small amount of current that is required to flow in the voltage divider. Under worst case design considerations, this sensing current will not exceed 500 μ A. This low current permits the use of .5W or smaller precision resistors, thus allowing even greater monitor accuracy. For example, when sensing a voltage of 110 VAC, the power dissipated in the divider network is only 45mW. Figure 24 shows a typical AC Line Monitor circuit. The threshold is determined by selecting the value of R1 and R2. Best accuracy is achieved when R1 is equal to or less than 2.5Kohm. Once R1 is selected, the value of R2 can be determined with the following equation.

$$R2 = \frac{R1 R_{th} (V_{th} - V_{ref})}{V_{ref}(R_{th} + R1) - R1 V}$$

Where

V_{th} = Selected AC or DC switching level
 V_{ref} = 1.34V
 R_{th} = 2.5Kohm
 V = 4.3V

This equation has been solved graphically in Figure 25.

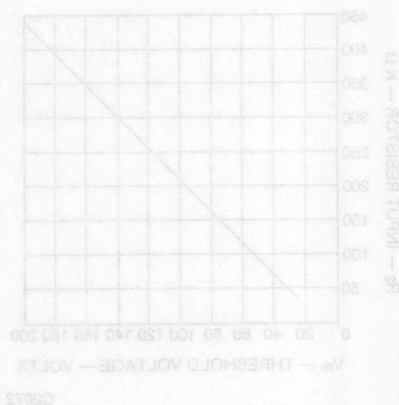


Fig. 25. Input Resistor vs. Threshold Voltage

The monitor circuit shown in Figure 24 consists of three elements. The first is an Optologic power supply, the second is the voltage divider, and the third is the retriggerable one-shot.

The power supply consists of a capacitor voltage divider and 5V regulator. A capacitor divider was used to minimize the power consumption from the AC line. This power supply will provide over 15 mA when the line voltage exceeds 80V RMS.

FORMER HARRIS OPTOCOUPLER PRODUCTS

Products described in this Data Book section include optocouplers formerly manufactured by Harris Semiconductor. These products were acquired in 1991 when QTC purchased Harris' optoelectronics business.

A new OPTOPLANAR™ assembly process is now in use for all former Harris 6-pin Optocoupler Products. A brief description of this process can be found on page 7 of this Data Book.

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FORMER HARRIS OPTOCOUPPLERS

Alphanumeric Product Listing

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H11A3	2-13	H24A2	2-47
H11A4	2-13	H24B1	2-51
H11A5	2-13	H24B2	2-51
H11AG1	2-17	MOC3009	2-55
H11AG2	2-17	MOC3010	2-55
H11AG3	2-17	MOC3011	2-55
H11B1	2-21	MOC3012	2-55
H11B2	2-21	MOC3020	2-61
H11B3	2-21	MOC3021	2-61
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H11C2	2-25	MOC3023	2-61
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H11C4	2-25		
H11C5	2-25		
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H11L2	2-35		
H11L3	2-35		
H11C1	2-25		
H11C2	2-25		
H11C3	2-25		
H11C4	2-25		
H11C5	2-25		
H11C6	2-25		
H11B1	2-21		
H11B2	2-21		
H11B3	2-21		
H11A1	2-13		
H11A2	2-13		
H11A3	2-13		
H11A4	2-13		
H11A5	2-13		
H11AG1	2-17		
H11AG2	2-17		
H11AG3	2-17		
4N40	2-7		
4N39	2-7		

OPTOCOUPLEDERS TRANSISTOR-OUTPUT

EQUIVALENT CIRCUIT	PART NUMBER	CTR _{CE(SAT)} MIN.		CTR _{CE} MIN.			BV _{CEO}	VDE ^{1,2} AVAIL	WITHSTAND TEST VOLTAGE	PAGE
		@ I _F =	mA	@ V _{CE} =	V	I _F = mA				
ANODE 1 CATH. 2 3 4 EMIT. 5 COL. 6 BASE C2079	H11A1	5%	10	50%	10	10	30		7500 VAC PEAK	2-13
	H11A2	5%	10	20%	10	10	30		7500 VAC PEAK	2-13
	H11A3	5%	10	20%	10	10	30		7500 VAC PEAK	2-13
	H11A4	5%	10	10%	10	10	30		7500 VAC PEAK	2-13
	H11A5	5%	10	30%	10	10	30		7500 VAC PEAK	2-13
	H11AG1	25%	2.0	300%	5	1.0	30		7500 VAC PEAK	2-17
	H11AG1	25%	2.0	100%	0.6	1.0	30		7500 VAC PEAK	2-17
	H11AG1	25%	2.0	100%	1.5	0.2	30		7500 VAC PEAK	2-17
	H11AG2	25%	2.0	200%	5	1.0	30		7500 VAC PEAK	2-17
	H11AG2	25%	2.0	50%	0.6	1.0	30		7500 VAC PEAK	2-17
	H11AG2	25%	2.0	50%	1.5	0.2	30		7500 VAC PEAK	2-17
	H11AG3	25%	2.0	100%	5	1.0	30		7500 VAC PEAK	2-17
	H11AG3	25%	2.0	20%	0.6	1.0	30		7500 VAC PEAK	2-17

OPTOCOUPLEDERS DARLINGTON-OUTPUT

EQUIVALENT CIRCUIT	PART NUMBER	CTR _{CE(SAT)} MIN.			CTR _{CE} MIN. @ IF = mA	BV _{CEO} MIN VOLT	VDE ^{1,2} AVAIL	WITHSTAND TEST VOLTAGE	PAGE
		@ IF =	mA	VCE(SAT)					
	H11B1	100%	1.0	1.0V	500% 1.0	25		7500 VAC PEAK	2-21
	H11B2	100%	1.0	1.0V	200% 1.0	25		7500 VAC PEAK	2-21
	H11B3	100%	1.0	1.0V	100% 1.0	25		7500 VAC PEAK	2-21

OPTOCOUPLEDERS SCR-OUTPUT

EQUIVALENT CIRCUIT	PART NUMBER	I _{FT} Max @ VAK =		V _{DM} MIN	V _{RM} MIN	VDE ^{1,2} AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
			V					
 ST1602	4N39	30mA	50	200V	200V		7500 VAC PEAK	2-7
	4N39	14mA	100	200V	200V		7500 VAC PEAK	2-7
	4N40	30mA	50	400V	400V		7500 VAC PEAK	2-7
	4N40	14mA	100	400V	400V		7500 VAC PEAK	2-7
	H11C1	20mA	50	200V	200V		7500 VAC PEAK	2-25
	H11C1	11mA	100	200V	200V		7500 VAC PEAK	2-25
	H11C2	20mA	50	200V	200V		7500 VAC PEAK	2-25
	H11C2	11mA	100	200V	200V		7500 VAC PEAK	2-25
	H11C3	30mA	50	200V	200V		7500 VAC PEAK	2-25
	H11C3	14mA	100	200V	200V		7500 VAC PEAK	2-25
	H11C4	20mA	50	400V	400V		7500 VAC PEAK	2-25
	H11C4	11mA	100	400V	400V		7500 VAC PEAK	2-25
	H11C5	20mA	50	400V	400V		7500 VAC PEAK	2-25
	H11C5	11mA	100	400V	400V		7500 VAC PEAK	2-25
	H11C6	30mA	50	400V	400V		7500 VAC PEAK	2-25
	H11C6	14mA	100	400V	400V		7500 VAC PEAK	2-25

¹To order VDE Device, Add -300 suffix to part number

²VDE qualification pending. Call QT.

OPTOCOUPLER FET-OUTPUT

EQUIVALENT CIRCUIT	PART NUMBER	BV ₄₆ MIN	r ₄₆ MAX.	r ₆₄ MAX.	VDE ^{1,2} AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
	H11F1	30V	200Ω	200Ω		7500 VAC PEAK	2-31
	H11F2	30V	330Ω	330Ω		7500 VAC PEAK	2-31
	H11F3	30V	470Ω	470Ω		7500 VAC PEAK	2-31

OPTOCOUPLER SCHMITT TRIGGER OUTPUT

EQUIVALENT CIRCUIT	PART NUMBER	IF _(ON) MAX.	IF _(ON) MIN.	VOL MAX.	VDE ^{1,2} AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
	H11L1	1.6mA		0.4V		7500 VAC PEAK	2-35
	H11L2	10.0mA		0.4V		7500 VAC PEAK	2-35
	H11L3	5.0mA		0.4V		7500 VAC PEAK	2-35
	H11N1	3.2mA	0.8mA	0.5V		7500 VAC PEAK	2-41
	H11N2	5.0mA	2.3mA	0.5V		7500 VAC PEAK	2-41
	H11N3	10.0mA	4.1mA	0.5V		7500 VAC PEAK	2-41

OPTOCOUPLER TRIAC OUTPUT

EQUIVALENT CIRCUIT	PART NUMBER	I _{FT} MAX.	V _{DRM} MIN.	VDE ^{1,2} AVAIL.	WITHSTAND TEST VOLTAGE	PAGE
*DO NOT CONNECT (TRIAC SUBSTRATE)	MOC3009	30mA	250V		7500 VAC PEAK	2-55
	MOC3010	15mA	250V		7500 VAC PEAK	2-55
	MOC3011	10mA	250V		7500 VAC PEAK	2-55
	MOC3012	5mA	250V		7500 VAC PEAK	2-55
	MOC3020	30mA	400V		7500 VAC PEAK	2-61
	MOC3021	15mA	400V		7500 VAC PEAK	2-61
	MOC3022	10mA	400V		7500 VAC PEAK	2-61
	MOC3023	5mA	400V		7500 VAC PEAK	2-61

¹ To order VDE device, add .300 suffix to part number

² VDE qualification pending. Call QT.

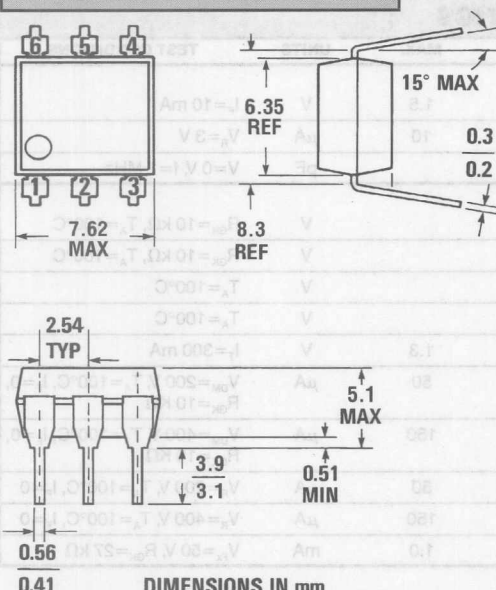
OPTOCOUPLER LINE DRIVER							EQUIVALENT CIRCUIT
PART NUMBER	IF MAX	IF MAX	VOL MAX	VOL AVAIL	WITHSTAND TEST VOLTAGE	PAGE	
HT1P1	30V	300V	300V	30V	1500 VAC PEAK	2-31	
HT1P2	30V	300V	300V	30V	1500 VAC PEAK	2-31	
HT1P3	30V	<100V	<100V	30V	1500 VAC PEAK	2-31	ST1800

OPTOCOUPLER LINE DRIVER							EQUIVALENT CIRCUIT
PART NUMBER	IF MAX	IF MAX	VOL MAX	VOL AVAIL	WITHSTAND TEST VOLTAGE	PAGE	
HT1L1	10mA		0.4V	0.4V	1500 VAC PEAK	2-32	
HT1L2	10mA		0.4V	0.4V	1500 VAC PEAK	2-32	
HT1L3	5mA		0.4V	0.4V	1500 VAC PEAK	2-32	
HT1M1	5.5mA	0.5mA	0.5V	0.5V	1500 VAC PEAK	2-41	
HT1M2	5.5mA	0.5mA	0.5V	0.5V	1500 VAC PEAK	2-41	
HT1M3	10.0mA	1.0mA	0.5V	0.5V	1500 VAC PEAK	2-41	ST1801

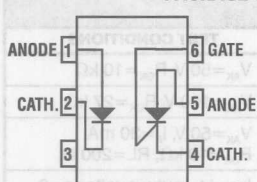
OPTOCOUPLER LINE DRIVER							EQUIVALENT CIRCUIT
PART NUMBER	IF MAX	IF MAX	VOL MAX	VOL AVAIL	WITHSTAND TEST VOLTAGE	PAGE	
MO-C3008	50mA	50mA	350V	350V	1500 VAC PEAK	2-55	
MO-C3010	15mA	15mA	350V	350V	1500 VAC PEAK	2-55	
MO-C3011	10mA	10mA	350V	350V	1500 VAC PEAK	2-55	
MO-C3012	5mA	5mA	350V	350V	1500 VAC PEAK	2-55	
MO-C3020	50mA	50mA	400V	400V	1500 VAC PEAK	2-51	
MO-C3021	15mA	15mA	400V	400V	1500 VAC PEAK	2-51	
MO-C3022	10mA	10mA	400V	400V	1500 VAC PEAK	2-51	
MO-C3023	5mA	5mA	400V	400V	1500 VAC PEAK	2-51	ST1802

* TO ORDER VOLTAGE, add 300 volts to part number.
† VOLTAGE qualification pending. Call Q.T.

PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**



Equivalent Circuit

DESCRIPTION

The 4N39 and 4N40 have a gallium-arsenide infrared emitting diode optically coupled with a light activated silicon controlled rectifier in a dual in-line package.

FEATURES & APPLICATIONS

- High efficiency, low degradation, liquid epitaxial LED
- 10 A, T²L compatible, solid state relay
- 25 W logic indicator lamp driver
- 400 V symmetrical transistor coupler
- Underwriters Laboratory (UL) recognized — File #E90700

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

- *Storage temperature -55°C to 150°C
- *Operating temperature -55°C to 100°C
- *Lead solder temperature 260°C for 10 sec
- *Total power dissipation (-55°C to 50°C) ... 450 mW
- Derate linearly (above 50°C) 9.0 mW/°C

INPUT DIODE

- *Power dissipation (-55°C to 50°C) 100 mW
- Derate linearly (above 50°C) 2 mW/°C
- *Continuous forward current (-55°C to 50°C) 60 mA
- *Peak forward current (-55°C to 50°C) 1 A
- *Reverse voltage (-55°C to 50°C) 6 V

DETECTOR

- *Power dissipation (-55°C to 50°C) 400 mW
- Derate linearly (above 50°C) 8 mW/°C
- *Off-state and reverse voltage 4N39 200 V
- *(-55°C to +100°C) 4N40 400 V
- *Peak reverse gate voltage(-55°C to 50°C) 6 V
- *Direct on-state current (-55°C to 50°C) ... 300 mA
- *Surge on-state current (-55°C to 50°C) (100μs) 10 A
- *Peak gate current (-55°C to 50°C) 10 mA

*Indicates JEDEC Registered Data

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
*Forward voltage	V_F		1.1	1.5	V	$I_F = 10$ mA
*Reverse leakage current	I_R			10	μ A	$V_R = 3$ V
Capacitance	C_J		50		pF	$V = 0$ V, $f = 1$ MHz
OUTPUT DETECTOR						
*Peak off-state voltage (4N39)	V_{DM}	200			V	$R_{GK} = 10$ k Ω , $T_A = 100^\circ$ C
(4N40)	V_{DM}	400			V	$R_{GK} = 10$ k Ω , $T_A = 100^\circ$ C
*Peak reverse voltage (4N39)	V_{RM}	200			V	$T_A = 100^\circ$ C
(4N40)	V_{RM}	400			V	$T_A = 100^\circ$ C
*On-state voltage	V_T			1.3	V	$I_T = 300$ mA
*Off-state current (4N39)	I_{DM}			50	μ A	$V_{DM} = 200$ V, $T_A = 100^\circ$ C, $I_F = 0$, $R_{GK} = 10$ K Ω
(4N40)	I_{DM}			150	μ A	$V_{DM} = 400$ V, $T_A = 100^\circ$ C, $I_F = 0$, $R_{GK} = 10$ K Ω
*Reverse current (4N39)	I_R			50	μ A	$V_R = 200$ V, $T_A = 100^\circ$ C, $I_F = 0$
(4N40)	I_R			150	μ A	$V_R = 400$ V, $T_A = 100^\circ$ C, $I_F = 0$
*Holding current	I_R			1.0	mA	$V_{FX} = 50$ V, $R_{GK} = 27$ k Ω

TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
*Input current to trigger (4N39, 4N40)	I_{FT}			30	mA	$V_{AK} = 50$ V, $R_{GK} = 10$ k Ω
(4N39, 4N40)	I_{FT}			14	mA	$V_{AK} = 100$ V, $R_{GK} = 27$ k Ω
*Turn-on time	t_{on}			50	μ s	$V_{AK} = 50$ V, $I_F = 30$ mA, $R_{GK} = 10$ k Ω , $R_L = 200$ Ω
Package capacitance (input to output)				2	pF	Input to output voltage = 0 $f = 1$ MHz
Coupled dv/dt, input to output (figure 13)		500			V/ μ s	

ISOLATION CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Surge isolation voltage	V_{ISO}	7500			V	1 Minute
Isolation voltage	V_{ISO}	5300			V	1 Minute
*Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{LO} = 500$ VDC

*Indicates JEDEC Registered Data

TYPICAL CHARACTERISTICS

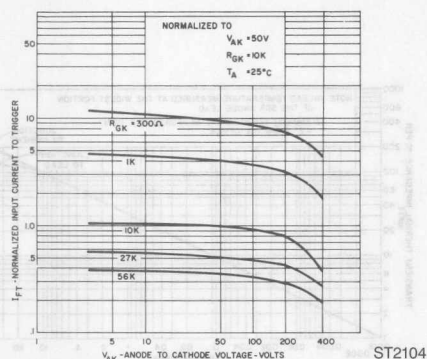


Figure 1. Input Current To Trigger vs. Anode-Cathode Voltage

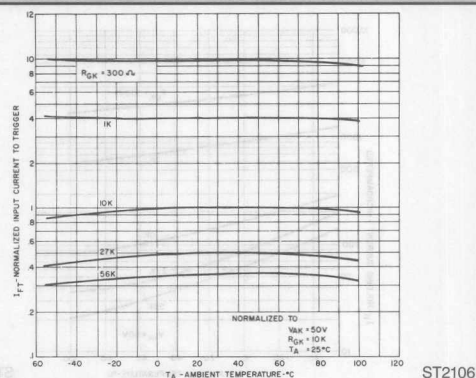


Figure 2. Input Current To Trigger vs. Temperature

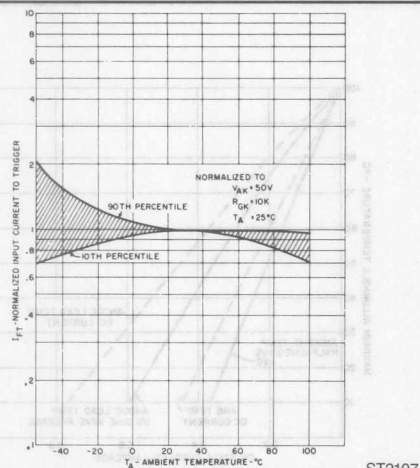


Figure 3. Input Current To Trigger Distribution vs. Temperature

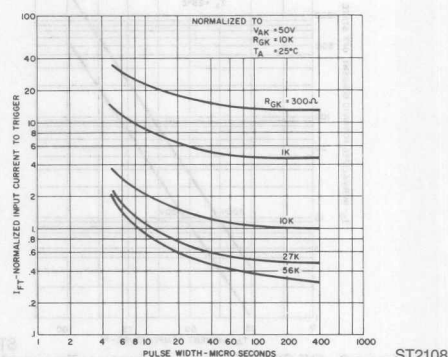


Figure 4. Input Current To Trigger vs. Pulse Width

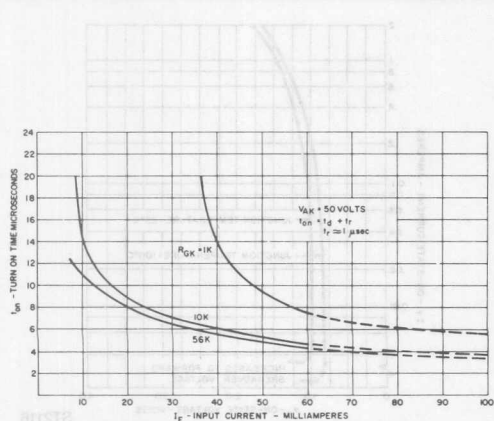


Figure 5. Turn-On Time vs. Input Current

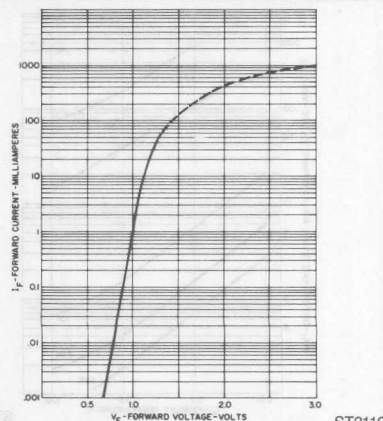


Figure 6. Input Characteristics I_F vs. V_F

TYPICAL CHARACTERISTICS OF OUTPUT (SCR)

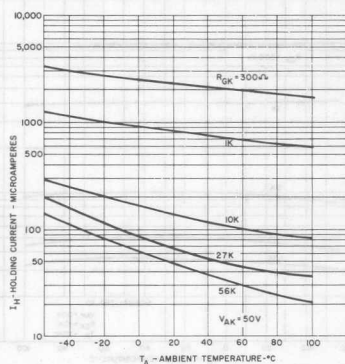


Figure 7. Holding Current vs. Temperature

ST2111

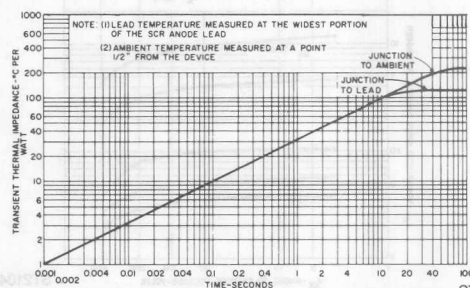


Figure 8. Maximum Transient Thermal Impedance

ST2112

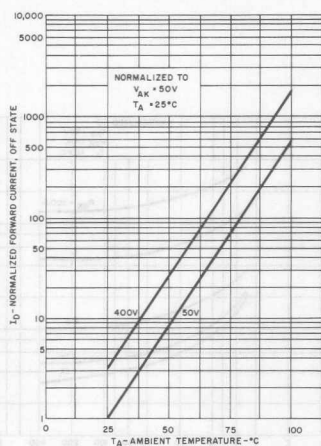


Figure 9. Off-State Forward Current vs. Temperature

ST2113

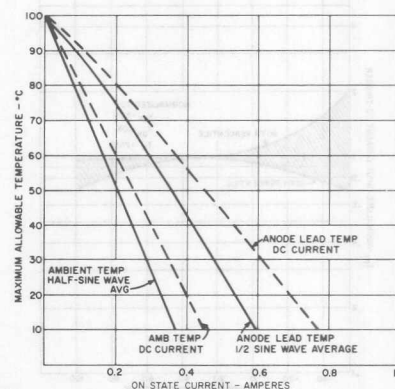


Figure 10. On-State Current vs. Maximum Allowable Temperature

ST2114

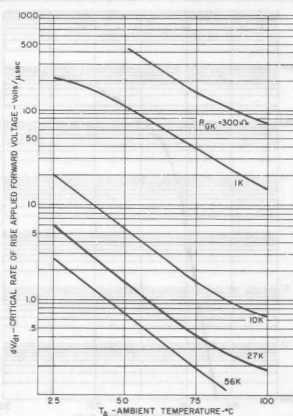


Figure 11. dv/dt vs. Temperature

ST2115

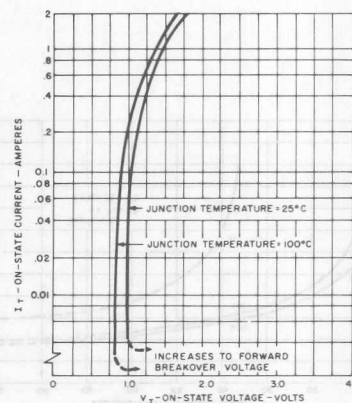


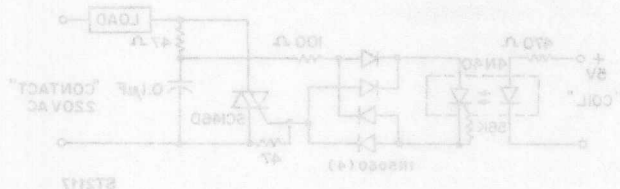
Figure 12. On-State Characteristics

ST2116

TYPICAL APPLICATIONS

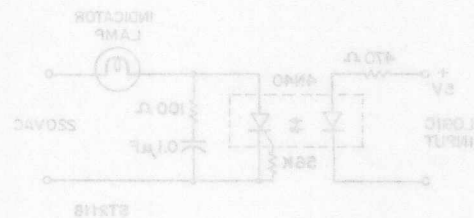
10A, T_L COMPATIBLE, SOLID STATE RELAY

Use of the 4N40 for high sensitivity, 3300V isolation capability, provides this highly reliable solid state relay design. This design is compatible with 74, 74S and 74H series T_L logic. Systems inputs and 220V AC loads up to 10A.



35W, LOGIC INDICATOR LAMP DRIVER

The high surge capability and non-reactive input characteristics of the 4N40 allow it to directly couple, without buffers, T_L and DTL logic to indicator alarm devices, without danger of introducing noise and logic glitches.



400V SYMMETRICAL TRANSISTOR COUPLER

Use of the high voltage PNP portion of the 4N40 provides a 400V transistor capable of conducting positive and negative signals with current transfer ratios of over 150%. This function is useful in remote instrumentation, high voltage power supplies and test equipment. Care should be taken not to exceed the 400 mW power dissipation rating when used at high voltages.

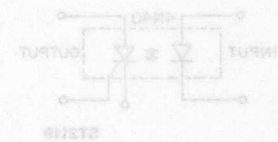
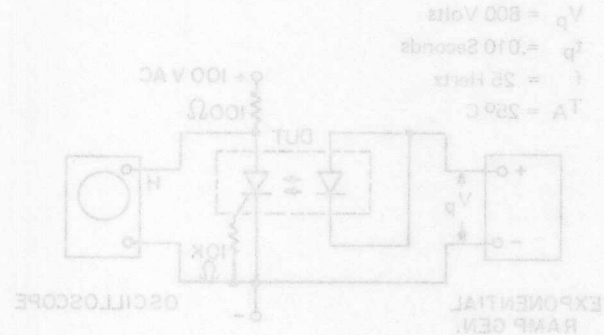
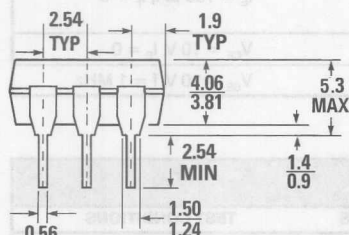
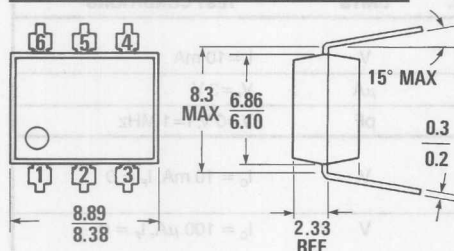


FIGURE 13
COUPLED 4N40 - TEST CIRCUIT

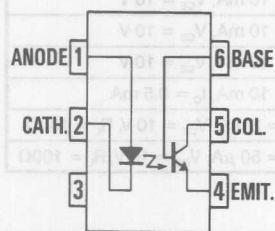


PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



C2079

Equivalent Circuit

DESCRIPTION

The H11A series consists of a gallium arsenide infrared emitting diode, coupled with a silicon phototransistor in a dual in-line package.

FEATURES

- Power supply regulators
- Digital logic inputs
- Microprocessor inputs
- Appliance sensor systems
- Industrial controls
- Underwriters Laboratory (UL) recognized—File #E90700

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead solder temperature 260°C for 10 sec

INPUT DIODE

Power dissipation (25°C ambient) 100 mW
Derate linearly (above 25°C ambient) ... 1.33 mW/°C
Continuous forward current 60 mA
Peak forward current (1 μs pulse, 300pps) 3 A
Reverse voltage 3 V

DETECTOR

Power dissipation (at 25°C ambient) 150 mW
Derate linearly (above 25°C) 2.0 mW/°C
V_{CEO} 30 V
V_{CBO} 70 V
V_{ECO} 7 V
Continuous collector current 100 mA

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.1	1.5	V	$I_F = 10\text{ mA}$
Reverse leakage current	I_R			10	μA	$V_R = 3\text{ V}$
Capacitance	C		50		pF	$V = 0\text{ V}, f = 1\text{ MHz}$
OUTPUT DETECTOR						
Breakdown voltage Collector to emitter	BV_{CEO}	30			V	$I_C = 10\text{ mA}, I_F = 0$
Breakdown voltage Collector to base	BV_{CBO}	70			V	$I_C = 100\text{ }\mu\text{A}, I_F = 0$
Breakdown voltage Emitter to Collector	BV_{ECO}	7			V	$I_E = 100\text{ }\mu\text{A}, I_F = 0$
Collector dark current	I_{CEO}		5	50	nA	$V_{CE} = 10\text{ V}, I_F = 0$
Capacitance	C		2		pF	$V_{CE} = 10\text{ V}, f = 1\text{ MHz}$

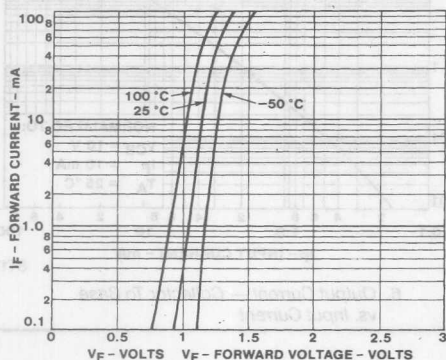
TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC current transfer ratio (H11A1)	I_C	5.0			mA	$I_F = 10\text{ mA}, V_{CE} = 10\text{ V}$
(H11A2)	I_C	2.0			mA	$I_F = 10\text{ mA}, V_{CE} = 10\text{ V}$
(H11A3)	I_C	2.0			mA	$I_F = 10\text{ mA}, V_{CE} = 10\text{ V}$
(H11A4)	I_C	1.0			mA	$I_F = 10\text{ mA}, V_{CE} = 10\text{ V}$
(H11A5)	I_C	3.0			mA	$I_F = 10\text{ mA}, V_{CE} = 10\text{ V}$
Saturation voltage	$V_{CE(SAT)}$		0.1	0.4	V	$I_F = 10\text{ mA}, I_C = 0.5\text{ mA}$
Rise/fall time	$t_{r/f}$		2		μs	$I_{CE} = 2\text{ mA}, V_{CE} = 10\text{ V}, R_L = 100\Omega$
Rise/fall time	$t_{r/f}$		300		ns	$I_{CB} = 50\text{ }\mu\text{A}, V_{CB} = 10\text{ V}, R_L = 100\Omega$

ISOLATION CHARACTERISTICS

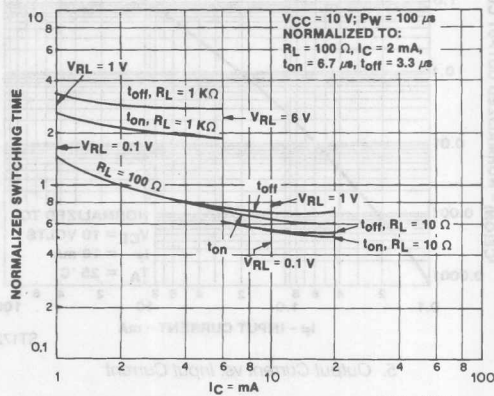
Surge isolation voltage	V_{ISO}	7500			V_{Peak}	1 Minute
Surge isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{IO} = 500\text{ VDC}$
Isolation capacitance	C_{ISO}			2	pF	$V_{IO} = 0, f = 1\text{ MHz}$

TYPICAL CHARACTERISTICS



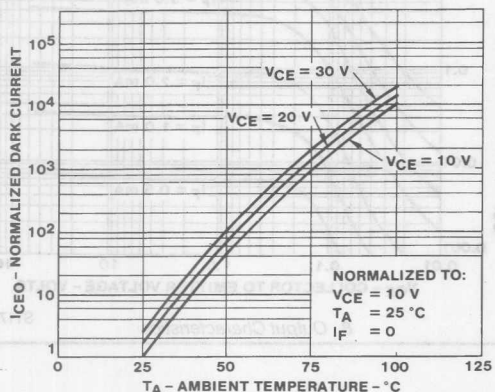
1. Input Characteristics

ST1723



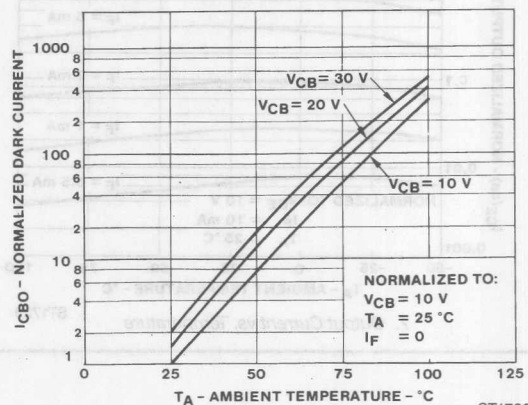
2. Switching Speed vs. Collector Current
(Not Saturated)

ST1724



3. Dark I_{CEO} Current vs. Temperature

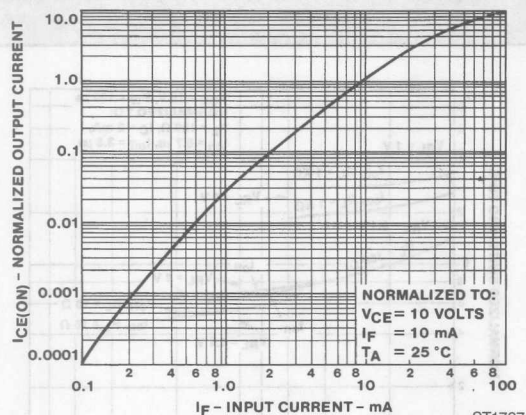
ST1725



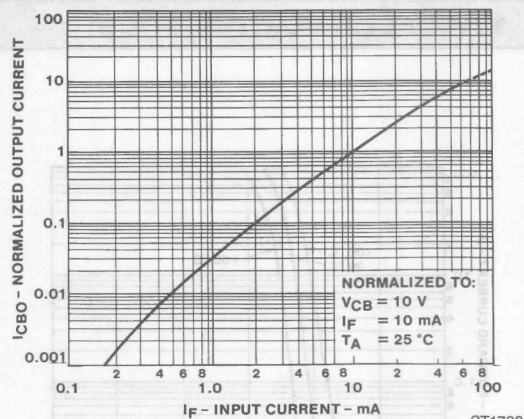
4. I_{CBO} vs. Temperature

ST1726

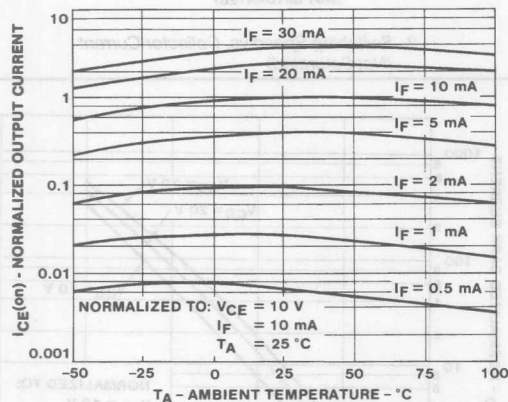
TYPICAL CHARACTERISTICS



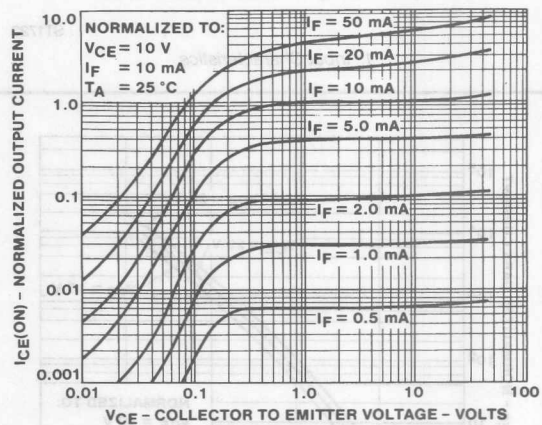
5. Output Current vs. Input Current



6. Output Current - Collector To Base vs. Input Current

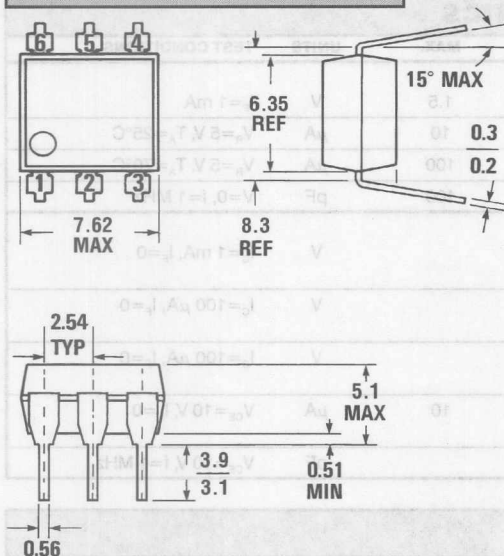


7. Output Current vs. Temperature



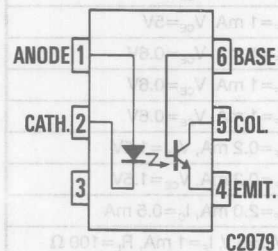
8. Output Characteristics

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE E

ST1603



Equivalent Circuit

DESCRIPTION

The H11AG series consists of a gallium-aluminum-arsenide infrared emitting diode coupled with a silicon phototransistor in a dual in-line package. This device provides the unique feature of high current transfer ratio at both low output voltage and low input current. This makes it ideal for use in low power logic circuits, telecommunications equipment and portable electronics isolation applications.

FEATURES

- High efficiency low degradation liquid epitaxial IRED
- Logic level compatible, input and output currents, with CMOS and LS/TTL
- High DC current transfer ratio at low input currents
- Underwriters Laboratory (UL) recognized — File #E90700

APPLICATIONS

- CMOS driven solid state relay
- Telephone ring detector
- Digital logic isolation

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -50°C to 150°C
Operating temperature -50°C to 100°C
Lead solder temperature 260°C for 10 sec

INPUT DIODE

Power dissipation (25°C ambient) 75 mW
Derate linearly (above 25°C) 1.0 mW/°C
Continuous forward current 50 mA
Reverse voltage 6 V

DETECTOR

Power dissipation (at 25°C ambient) 150 mW
Derate linearly (above 25°C ambient) 2.0 mW/°C
 V_{CEO} 30 V
 V_{CBO} 70 V
 V_{ECO} 7 V
Continuous collector current 50 mA

ELECTRICAL CHARACTERISTICS ($T_A = 0-70^\circ$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F			1.5	V	$I_F = 1 \text{ mA}$
Reverse current	I_R			10	μA	$V_R = 5 \text{ V}, T_A = 25^\circ\text{C}$
	I_R			100	μA	$V_R = 5 \text{ V}, T_A = 70^\circ\text{C}$
Capacitance	C_J			100	pF	$V = 0, f = 1 \text{ MHz}$
OUTPUT DETECTOR						
Breakdown voltage Collector to emitter	BV_{CEO}	30			V	$I_C = 1 \text{ mA}, I_F = 0$
Breakdown voltage Collector to base	BV_{CBO}	70			V	$I_C = 100 \mu\text{A}, I_F = 0$
Breakdown voltage Emitter to Collector	BV_{ECO}	7			V	$I_C = 100 \mu\text{A}, I_F = 0$
Leakage current Collector to emitter	I_{CEO}		5	10	μA	$V_{CE} = 10 \text{ V}, I_F = 0$
Capacitance	C_{CE}		2		pF	$V_{CE} = 10 \text{ V}, f = 1 \text{ MHz}$

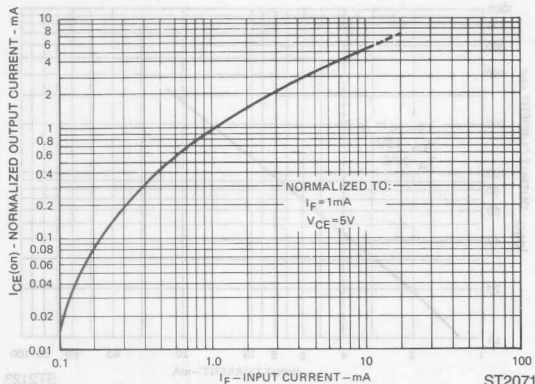
TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC current transfer ratio (H11AG1)	CTR	300			%	$I_F = 1 \text{ mA}, V_{CE} = 5 \text{ V}$
(H11AG2)	CTR	200			%	$I_F = 1 \text{ mA}, V_{CE} = 5 \text{ V}$
(H11AG3)	CTR	100			%	$I_F = 1 \text{ mA}, V_{CE} = 5 \text{ V}$
(H11AG1)	CTR	100			%	$I_F = 1 \text{ mA}, V_{CE} = 0.6 \text{ V}$
(H11AG2)	CTR	50			%	$I_F = 1 \text{ mA}, V_{CE} = 0.6 \text{ V}$
(H11AG3)	CTR	20			%	$I_F = 1 \text{ mA}, V_{CE} = 0.6 \text{ V}$
(H11AG1)	CTR	100			%	$I_F = 0.2 \text{ mA}, V_{CE} = 1.5 \text{ V}$
(H11AG2)	CTR	50			%	$I_F = 0.2 \text{ mA}, V_{CE} = 1.5 \text{ V}$
Saturation voltage	$V_{CE(SAT)}$			0.4	V	$I_F = 2.0 \text{ mA}, I_C = 0.5 \text{ mA}$
Turn-on time	t_{on}		5		μs	$V_{CC} = 5 \text{ V}, I_F = 1 \text{ mA}, R_L = 100 \Omega$
Turn-off time	t_{off}		5		μs	$V_{CC} = 5 \text{ V}, I_F = 1 \text{ mA}, R_L = 100 \Omega$

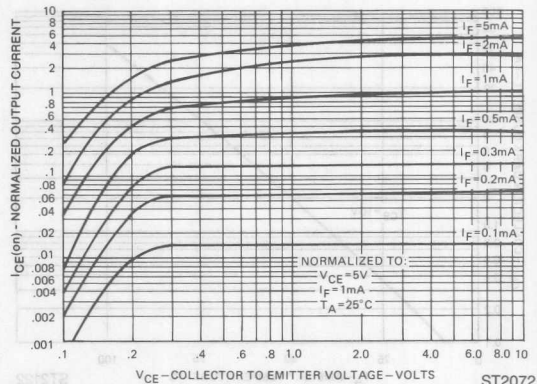
ISOLATION CHARACTERISTICS

Surge isolation voltage	V_{ISO}	7500		V_{Peak}	1 Minute
Surge isolation voltage	V_{ISO}	5300		V_{RMS}	1 Minute

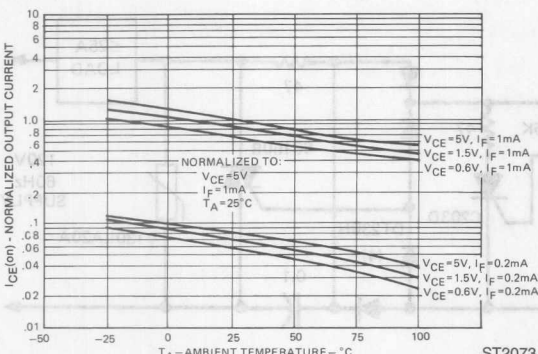
TYPICAL CHARACTERISTICS



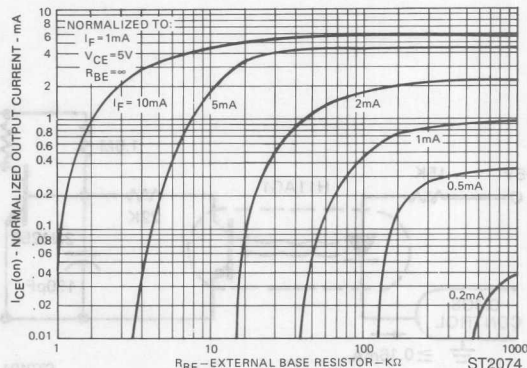
Output Current vs. Input Current



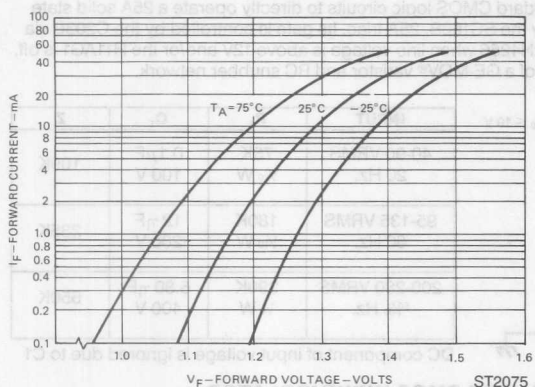
Output Current vs. Collector-Emitter Voltage



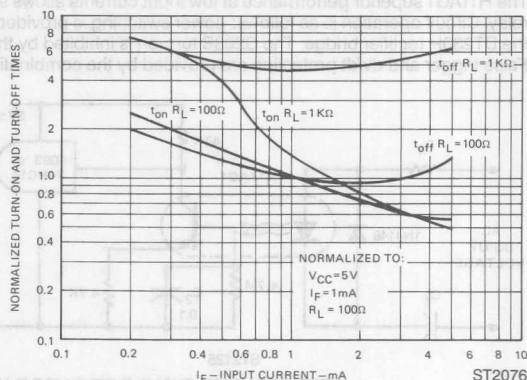
Output Current vs. Temperature



Output Current vs. Base Emitter Resistance

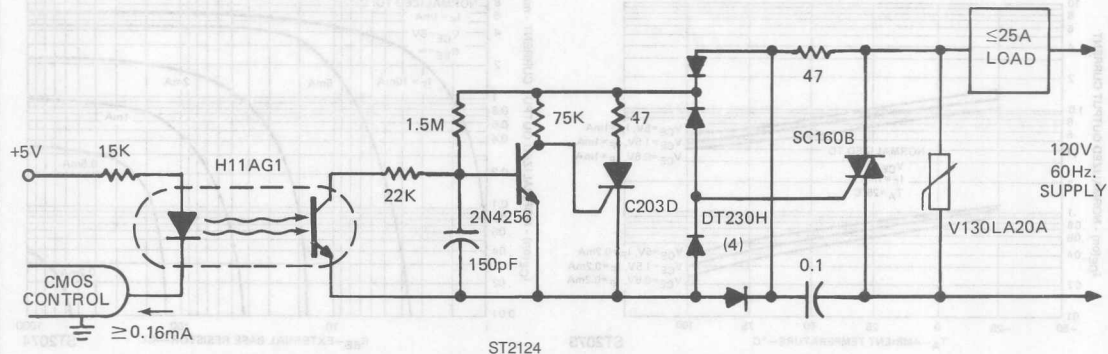
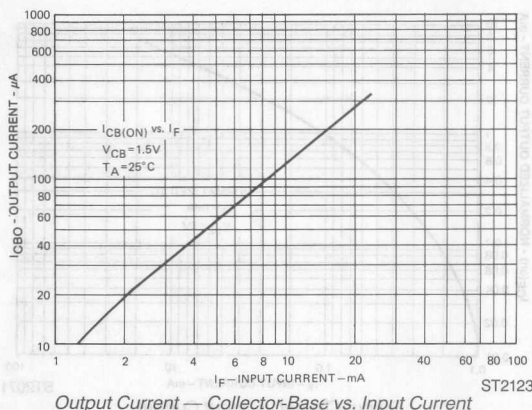
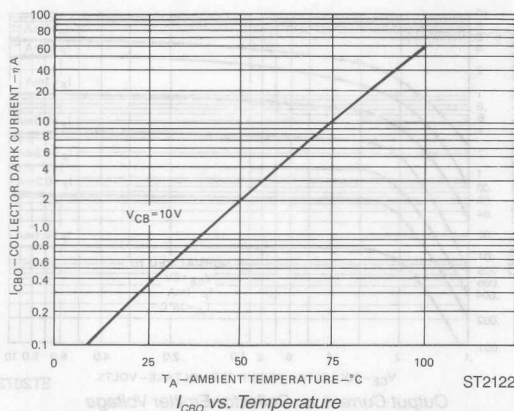


Input Voltage vs. Input Current



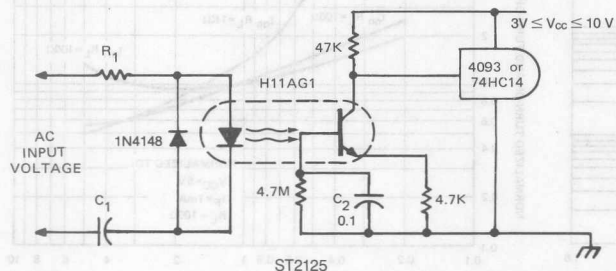
Switching Times vs. Input Current

TYPICAL CHARACTERISTICS



CMOS Input, 3KW, Zero Voltage Switching Solid State Relay

The H11AG1 superior performance at low input currents allows standard CMOS logic circuits to directly operate a 25A solid state relay. Circuit operation is as follows: power switching is provided by the SC160B, 25A triac. Its gate is controlled by the C203B via the DT230H rectifier bridge. The C203B turn-on is inhibited by the 2N4256 when line voltage is above 12V and/or the H11AG1 is off. False trigger and dv/dt protection are provided by the combination of a GE-MOV® varistor and RC snubber network.



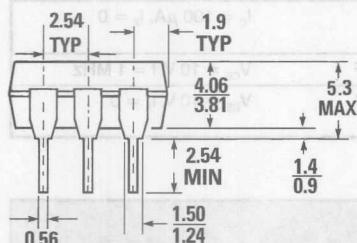
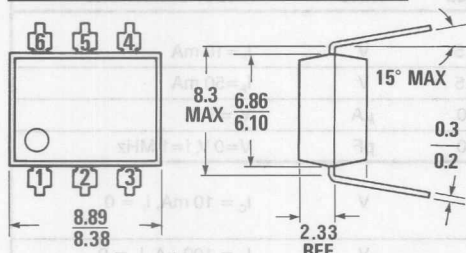
INPUT	R_1	C_1	Z
40-90 VRMS 20 Hz.	75K $\frac{1}{10} W$	0.1 μF 100 V	109K
95-135 VRMS 60 Hz.	180K $\frac{1}{10} W$	12 ηF 200 V	285K
200-280 VRMS 50/60 Hz.	390K $\frac{1}{4} W$	6.80 ηF 400 V	550K

DC component of input voltage is ignored due to C1

TELEPHONE RING DETECTOR/A.C. LINE CMOS INPUT ISOLATOR

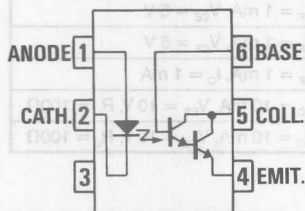
The H11AG1 uses less input power than the neon bulb traditionally used to monitor telephone and line voltages. Additionally, response time can be tailored to ignore telephone dial tap, switching transients and other undesired signals by modifying the value of C2. The high impedance to line voltage also can simplify board layout spacing requirements.

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE K

ST1603A



C2084

Equivalent Circuit

DESCRIPTION

The H11B series consists of a gallium arsenide infrared emitting diode, coupled with a silicon photodarlington transistor in a dual in-line package.

FEATURES

- High current transfer ratio
H11B1 - 500% min.
H11B2 - 200% min.
H11B3 - 100% min.
- Underwriters Laboratory (UL) recognized file #E90700

APPLICATIONS

- Isolated, logic controlled, indicator lamp switch
- Replace pulse transformers
- Form multiple contact, NO/NC relays
- Useful for telephone lines, SCR triggers, hospital monitoring systems, airborne systems, remote data gathering systems and remote control systems
- Use a low-current alarm monitor for battery powered supplies

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead solder temperature 260°C for 10 sec

INPUT DIODE

Power dissipation (25°C ambient) 100 mW
Derate linearly (above 25°C) 1.33 mW/°C
Continuous forward current 60 mA
Peak forward current (1 μ s pulse, 300pps) 3 A
Reverse voltage 3 V

DETECTOR

Power dissipation (at 25°C ambient) 150 mW
Derate linearly (above 25°C) 2.0 mW/°C
 V_{CEO} 25 V
 V_{CBO} 30 V
 V_{EBO} 7 V
Continuous collector current 100 mA

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage (H11B1, H11B2)	V_F	1.1	1.5		V	$I_F = 10\text{ mA}$
(H11B3)	V_F	1.1	1.5		V	$I_F = 50\text{ mA}$
Reverse current	I_R			10	μA	$V_R = 3\text{ V}$
Capacitance	C_j			50	pF	$V = 0\text{ V}, f = 1\text{ MHz}$
OUTPUT DETECTOR						
Breakdown voltage Collector to emitter	BV_{CEO}	25			V	$I_C = 10\text{ mA}, I_F = 0$
Breakdown voltage Collector to base	BV_{CBO}	30			V	$I_C = 100\text{ }\mu\text{A}, I_F = 0$
Breakdown voltage Emitter to Collector	BV_{ECO}	7			V	$I_C = 100\text{ }\mu\text{A}, I_F = 0$
Capacitance	C_{CE}		6		pF	$V_{CE} = 10\text{ V}, f = 1\text{ MHz}$
Leakage Current Collector to emitter	I_{CEO}		5	100	nA	$V_{CE} = 10\text{ V}, I_F = 0$

TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC current transfer ratio (H11B1)	I_C	5.0			mA	$I_F = 1\text{ mA}, V_{CE} = 5\text{ V}$
(H11B2)	I_C	2.0			mA	$I_F = 1\text{ mA}, V_{CE} = 5\text{ V}$
(H11B3)	I_C	1.0			mA	$I_F = 1\text{ mA}, V_{CE} = 5\text{ V}$
Saturation voltage	$V_{CE(SAT)}$		0.7	1.0	V	$I_F = 1\text{ mA}, I_C = 1\text{ mA}$
Turn-on time	$t_{(on)}$		125		μs	$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}, R_L = 100\Omega$
Turn-off time	$t_{(off)}$		100		μs	$I_C = 10\text{ mA}, V_{CE} = 10\text{ V}, R_L = 100\Omega$

ISOLATION CHARACTERISTICS

Surge isolation voltage	V_{ISO}	7500			V_{Peak}	1 Minute
Surge isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{I/O} = 500\text{ VDC}$
Isolation capacitance	C_{ISO}			2	pF	$V_{I/O} = 0, f = 1\text{ MHz}$

TYPICAL CHARACTERISTICS

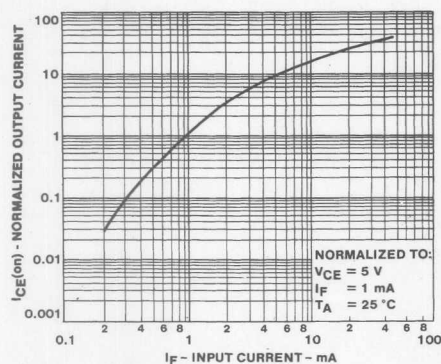


Fig. 1. Output Current vs. Input Current ST1731

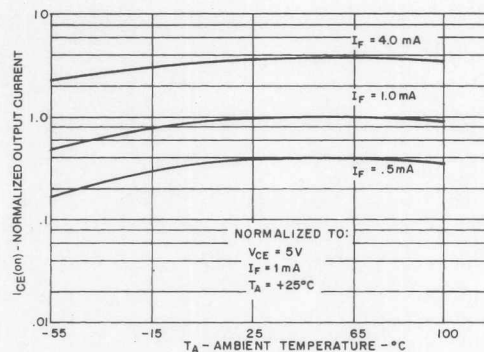


Fig. 2. Output Current vs. Temperature

ST1732

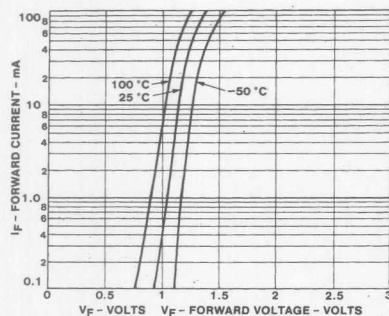


Fig. 3. Input Characteristics

ST1723

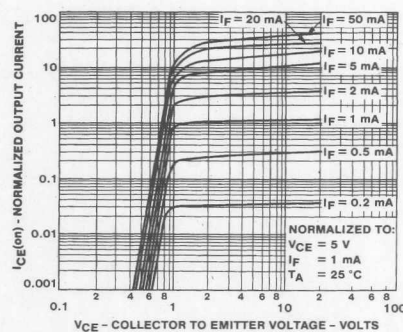


Fig. 4. Output Characteristics

ST1734

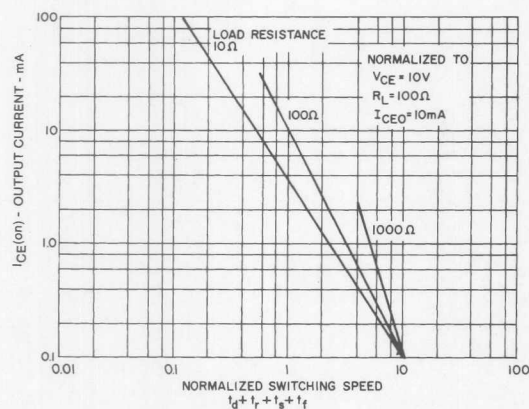


Fig. 5. Switching Speed vs. Output Current

ST1735

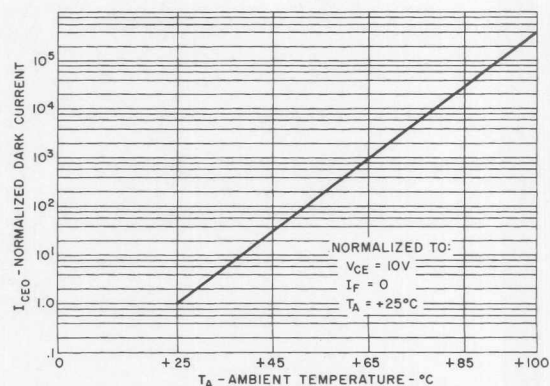


Fig. 6. Normalized Dark Current vs. Temperature

ST1736

TYPICAL CHARACTERISTICS

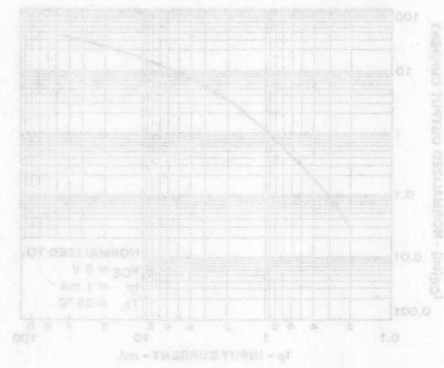


Fig. 1. Output Current vs. Input Current ST1731

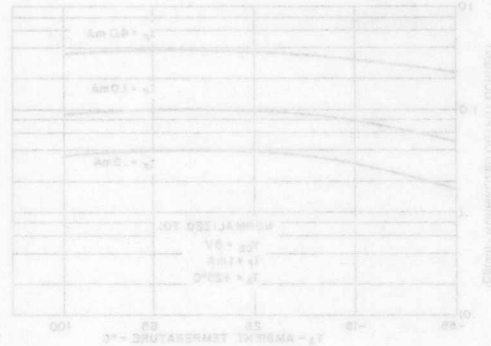


Fig. 2. Output Current vs. Temperature ST1732

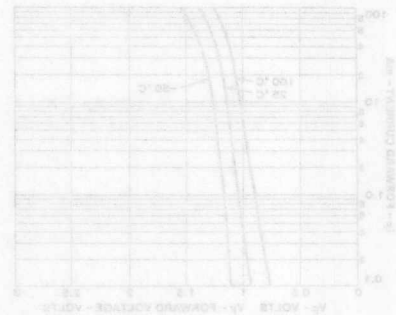


Fig. 3. Input Characteristics ST1733

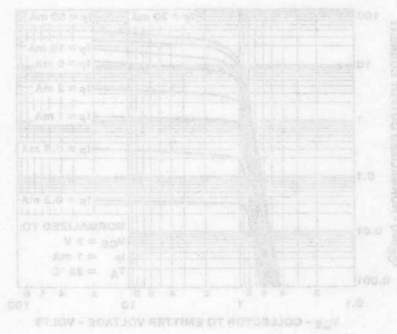


Fig. 4. Output Characteristics ST1734

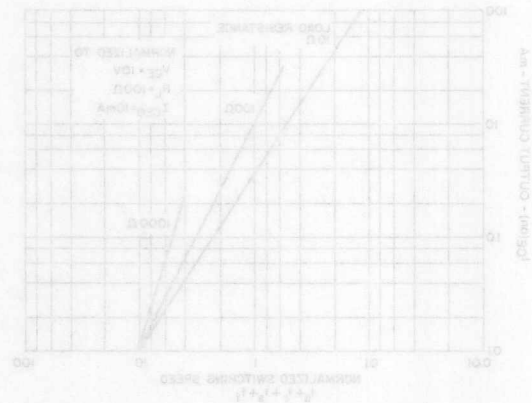


Fig. 5. Switching Speed vs. Output Current ST1735

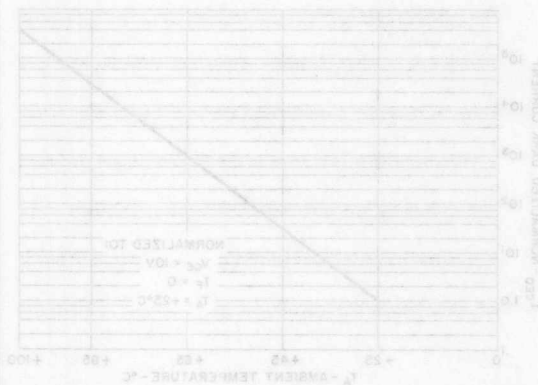
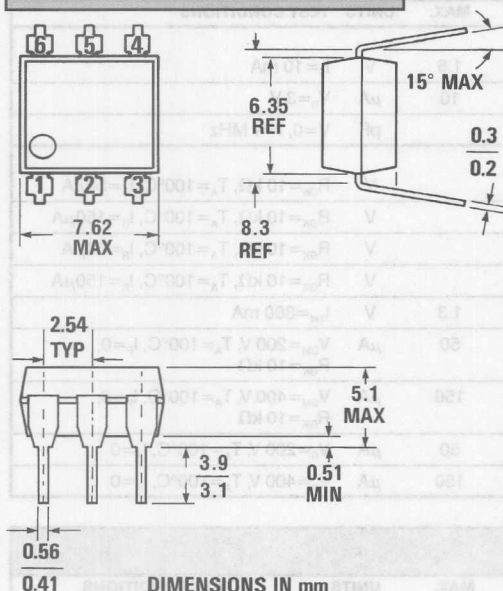


Fig. 6. Normalized Dark Current vs. Temperature ST1736

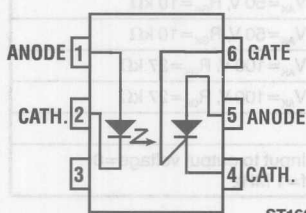
**H11C1 H11C2 H11C3
H11C4 H11C5 H11C6**

2

PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**



Equivalent Circuit

DESCRIPTION

The H11C series consists of a gallium-arsenide infrared emitting diode optically coupled with a light activated silicon controlled rectifier in a dual-in-line package.

FEATURES & APPLICATIONS

- 10 A, T²L compatible, solid state relay
- 25 W logic indicator lamp driver
- High efficiency, low degradation, liquid epitaxial LED
- 200 V symmetrical transistor coupler (H11C1, H11C2, H11C3)
- 400 V symmetrical transistor coupler (H11C4, H11C5, H11C6)
- Underwriters Laboratory (UL) recognized—File #E90700

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ$ unless otherwise specified)

TOTAL PACKAGE

Storage temperature -55°C to 150°C
Operating temperature 55°C to 100°C
Lead solder temperature -260°C for 10 sec

INPUT DIODE

Power dissipation 100 mW
Derate linearly (above 25°C) $1.33 \text{ mW}/^\circ\text{C}$
Continuous forward current 60 mA
Peak forward current ($1 \mu\text{s}$ pulse, 300 pps) 3 A
Reverse voltage 6 V

DETECTOR

Power dissipation (ambient) 400 mW
Derate linearly (above 25°C ambient) $5.3 \text{ mW}/^\circ\text{C}$
Power dissipation (case) 1 W
Derate linearly (above 25°C case) $13.3 \text{ mW}/^\circ\text{C}$
Peak reverse gate voltage 6 V
RMS on-state current 300 mA
Peak on-state current ($100 \mu\text{s}$, 1% duty cycle) ... 10 A
Surge current (10 ms) 5 A
Peak forward voltage (H11C1, H11C2, H11C3) .. 200 V
Peak forward voltage (H11C4, H11C5, H11C6) . 400 V

H11C1 H11C2 H11C3 H11C4 H11C5 H11C6

ELECTRICAL CHARACTERISTICS ($T_A=25^\circ$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.2	1.5	V	$I_F=10$ mA
Reverse leakage current	I_R			10	μ A	$V_R=3$ V
Capacitance	C		50		pF	$V=0$, $f=1$ MHz
OUTPUT DETECTOR						
Off-state voltage (H11C1, H11C2, H11C3)	V_{DM}	200			V	$R_{GK}=10$ k Ω , $T_A=100^\circ$ C, $I_R=50$ μ A
(H11C4, H11C5, H11C6)	V_{DM}	400			V	$R_{GK}=10$ k Ω , $T_A=100^\circ$ C, $I_R=150$ μ A
Reverse voltage (H11C1, H11C2, H11C3)	V_{RM}	200			V	$R_{GK}=10$ k Ω , $T_A=100^\circ$ C, $I_R=50$ μ A
(H11C4, H11C5, H11C6)	V_{RM}	400			V	$R_{GK}=10$ k Ω , $T_A=100^\circ$ C, $I_R=150$ μ A
On-state voltage	V_{TM}		1.1	1.3	V	$I_{TM}=300$ mA
Off-state current (H11C1, H11C2, H11C3)	I_{DM}			50	μ A	$V_{DM}=200$ V, $T_A=100^\circ$ C, $I_F=0$, $R_{GK}=10$ k Ω
(H11C4, H11C5, H11C6)	I_{DM}			150	μ A	$V_{DM}=400$ V, $T_A=100^\circ$ C, $I_F=0$, $R_{GK}=10$ k Ω
Reverse current (H11C1, H11C2, H11C3)	I_R			50	μ A	$V_R=200$ V, $T_A=100^\circ$ C, $I_F=0$
(H11C4, H11C5, H11C6)	I_R			150	μ A	$V_R=400$ V, $T_A=100^\circ$ C, $I_F=0$

TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Input current to trigger (H11C1, H11C2, H11C4, H11C5)	I_{FT}			20	mA	$V_{AK}=50$ V, $R_{GK}=10$ k Ω
(H11C3, H11C6)	I_{FT}			30	mA	$V_{AK}=50$ V, $R_{GK}=10$ k Ω
(H11C1, H11C2, H11C4, H11C5)	I_{FT}			11	mA	$V_{AK}=100$ V, $R_{GK}=27$ k Ω
(H11C3, H11C6)	I_{FT}			14	mA	$V_{AK}=100$ V, $R_{GK}=27$ k Ω
Coupled dv/dt, input to output (fig. 13)	dv/dt	500			V/ μ s	
Input to output capacitance				2	pF	Input to output voltage=0 $f=1$ MHz

ISOLATION CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Surge isolation voltage	V_{ISO}	7500			V	1 Minute
Isolation voltage	V_{ISO}	5300			V	1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{LO}=500$ VDC

H11C1 H11C2 H11C3 H11C4 H11C5 H11C6

TYPICAL CHARACTERISTICS

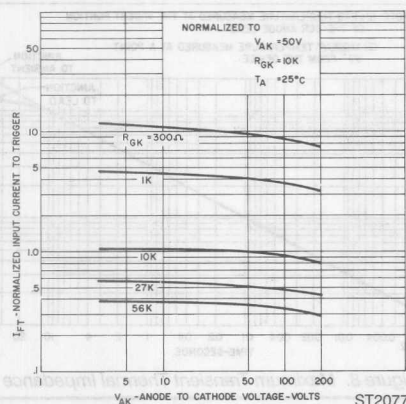


Figure 1. Input Current To Trigger vs. Anode-Cathode Voltage

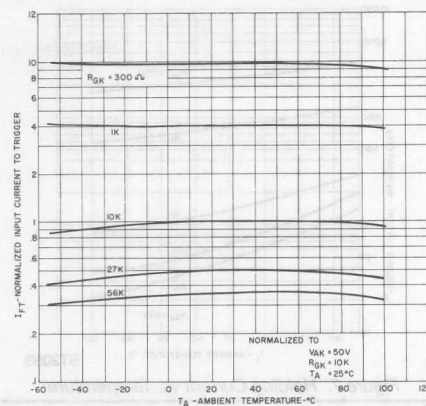


Figure 2. Input Current To Trigger vs. Temperature

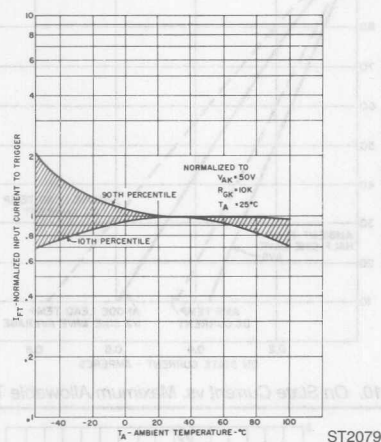


Figure 3. Input Current to Trigger Distribution vs. Temperature

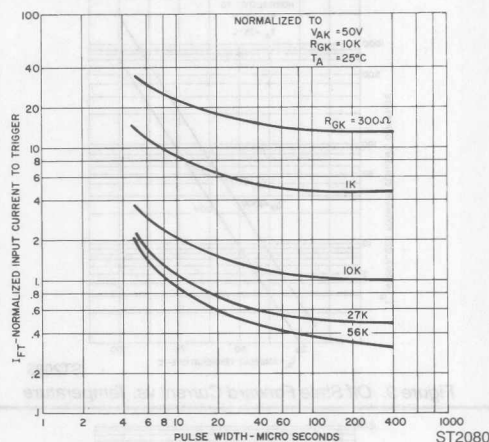


Figure 4. Input Current to Trigger vs. Pulse Width

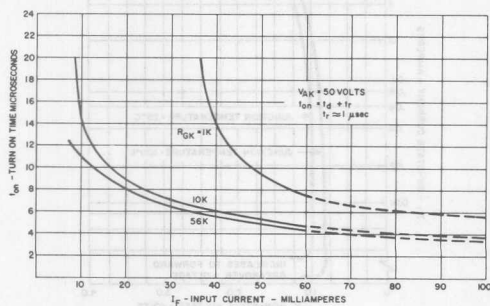


Figure 5. Turn on Time vs. Input Current

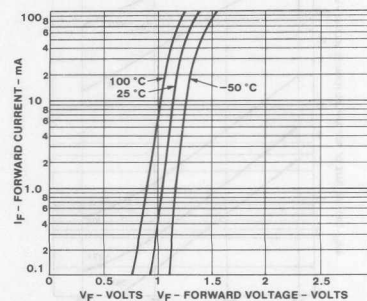


Figure 6. Input Characteristics I_F vs. V_F

TYPICAL CHARACTERISTICS OF OUTPUT (SCR)

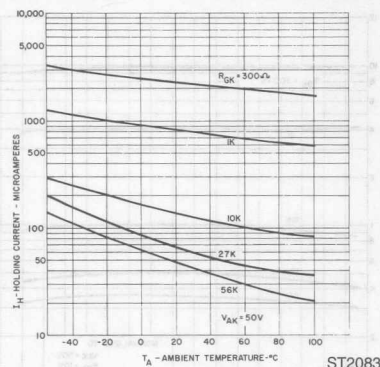


Figure 7. Holding Current vs. Temperature

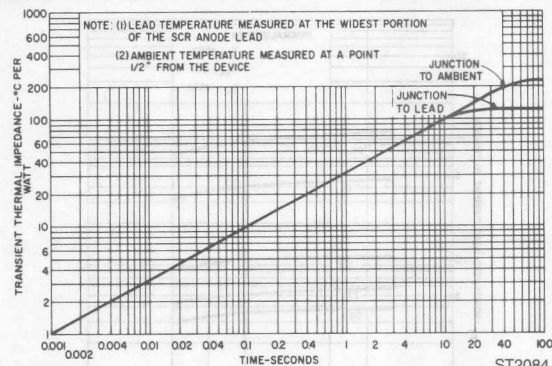


Figure 8. Maximum Transient Thermal Impedance

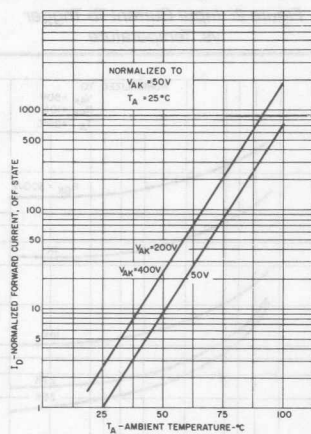


Figure 9. Off State Forward Current vs. Temperature

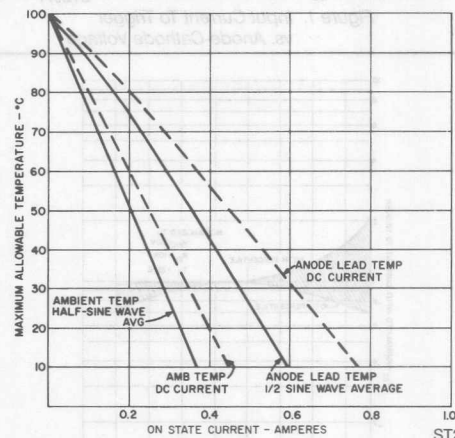


Figure 10. On State Current vs. Maximum Allowable Temperature

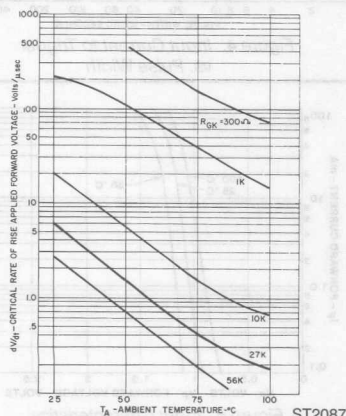


Figure 11. dV/dt vs. Temperature

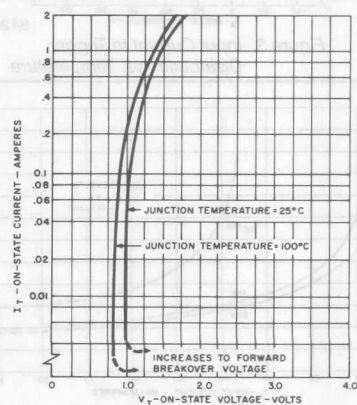
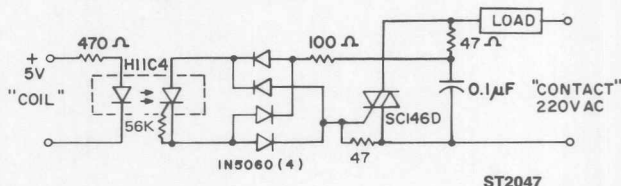


Figure 12. On-State Characteristics

TYPICAL APPLICATIONS

10A, T²L COMPATIBLE, SOLID STATE RELAY

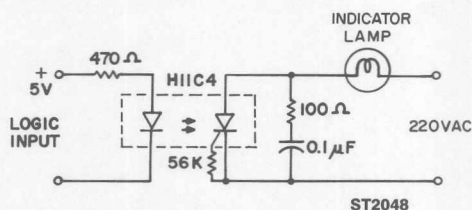
Use of the H11C4 for high sensitivity, 5300V isolation capability, provides this highly reliable solid state relay design. This design is compatible with 74, 74S and 74H series T²L logic systems inputs and 220V AC loads up to 10A.



ST2047

25W LOGIC INDICATOR LAMP DRIVER

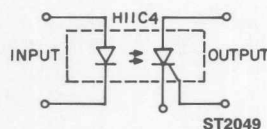
The high surge capability and non-reactive input characteristics of the H11C allow it to directly couple, without buffers, T²L and DTL logic to indicator and alarm devices, without danger of introducing noise and logic glitches.



ST2048

400V SYMMETRICAL TRANSISTOR COUPLER

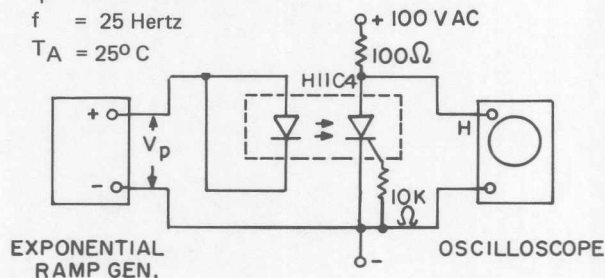
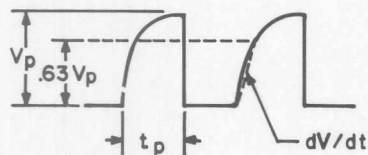
Use of the high voltage PNP portion of the H11C provides a 400V transistor capable of conducting positive and negative signals with current transfer ratios over 1%. This function is useful in remote instrumentation, high voltage power supplies and test equipment. Care should be taken not to exceed the H11C 400 mW power dissipation rating when used at high voltages.



ST2049

Fig 13.
Coupled dV/dt - Test circuit

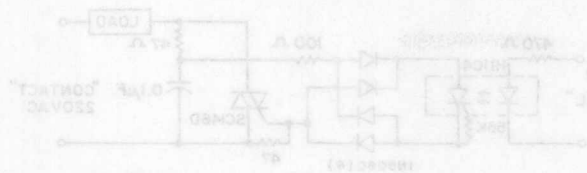
$V_p = 800$ Volts
 $t_p = .010$ Seconds
 $f = 25$ Hertz
 $T_A = 25^\circ$ C



ST2050

10A, T₁L COMPATIBLE, SOLID STATE RELAY

Use of the H11C4 for high sensitivity, 8500V isolation capability, provides this highly reliable solid state relay design. This design is compatible with T₁L and T₁H series T₁L logic systems inputs and 250V AC loads up to 10A.



STEP 17

25W LOGIC INDICATOR LAMP DRIVER

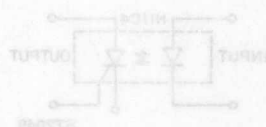
The high surge capability and non-reactive input characteristics of the H11C allow it to directly couple, without buffers, T₁L and DTL logic to indicator and alarm devices, without danger of introducing noise and logic glitches.



STEP 18

400V ASYMMETRICAL TRANSISTOR COUPLER

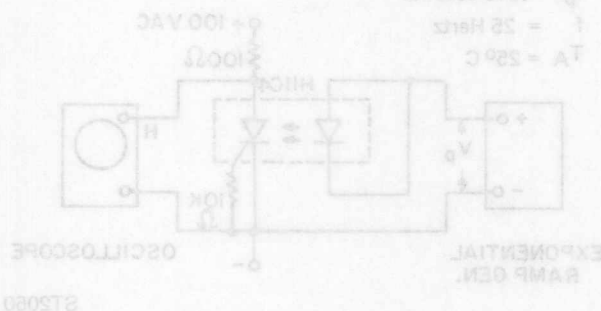
Use of the high voltage PNP portion of the H11C provides a 400V transistor capable of conducting positive and negative signals with current transfer ratios over 1%. This function is useful in remote instrumentation, high voltage power supplies and test equipment. Care should be taken not to exceed the H11C 400 mW power dissipation rating when used at high voltages.



STEP 19

Fig 12
Coupled 5V/5V - Test circuit

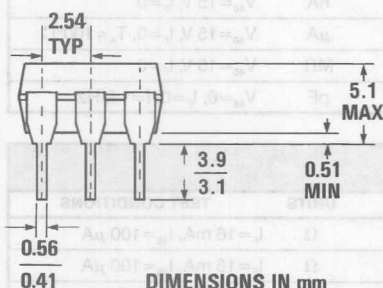
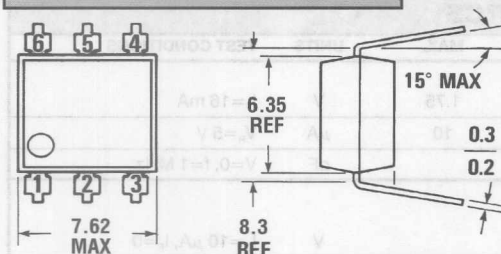
$V_p = 800 \text{ Vohms}$
 $t_p = 0.10 \text{ Seconds}$
 $f = 25 \text{ Hertz}$
 $T_A = 25^\circ \text{C}$



STEP 20

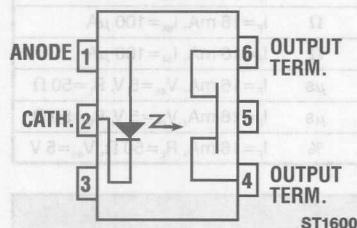


PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**

ST1603



ST1600

Equivalent Circuit

DESCRIPTION

The H11F series has a gallium-aluminum-arsenide infrared emitting diode coupled to a symmetrical bilateral silicon photodetector. The detector is electrically isolated from the input and performs like an ideal isolated FET designed for distortion-free control of low level ac and dc analog signals. The H11F series devices are mounted in dual in-line packages.

FEATURES

As a remote variable resistor—

- $\leq 100 \Omega$ to $\geq 300 \text{ M}\Omega$
- $\geq 99.9\%$ linearity
- $\leq 15 \text{ pF}$ shunt capacitance
- $\geq 100 \text{ G}\Omega$ I/O isolation resistance

As an analog switch—

- Extremely low offset voltage
- 60 V pk-pk signal capability
- No charge injection or latchup
- $t_{on}, t_{off} \leq 15 \mu\text{s}$
- Underwriters Laboratory (UL) recognized—File #E90700

APPLICATIONS

As a variable resistor—

- Isolated variable attenuator
- Automatic gain control
- Active filter fine tuning/band switching

As an analog switch—

- Isolated sample and hold circuit
- Multiplexed, optically isolated A/D conversion

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−55°C to 100°C
Lead solder temperature	260°C for 10 sec

INPUT DIODE

Power dissipation (25°C ambient)	100 mW
Derate linearly (above 25°C)	1.33 mW/°C
Continuous forward current	60 mA
Peak forward current (10μs pulse, 1% duty cycle)	1 A
Reverse voltage	6 V

DETECTOR

Power dissipation (at 25°C ambient)	300 mW
Derate linearly (above 25°C ambient)	4 mW/°C
Breakdown voltage (H11F1, H11F2)	$\pm 30 \text{ V}$
Breakdown voltage (H11F3)	$\pm 15 \text{ V}$
Continuous detector current	$\pm 100 \text{ mA}$

ELECTRICAL CHARACTERISTICS ($T_A=25^\circ$ Unless Otherwise Specified)**INDIVIDUAL COMPONENT CHARACTERISTICS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.1	1.75	V	$I_F=16$ mA
Reverse current	I_R			10	μ A	$V_R=5$ V
Capacitance	C_J		50		pF	$V=0$, $f=1$ MHz
OUTPUT DETECTOR (Either polarity)						
Breakdown voltage						
(H11F1, H11F2)	BV_{46}	30			V	$I_C=10$ μ A, $I_F=0$
(H11F3)	BV_{46}	15			V	$I_C=10$ μ A, $I_F=0$
Off-state dark current	I_{46}			50	nA	$V_{46}=15$ V, $I_F=0$
	I_{46}			50	μ A	$V_{46}=15$ V, $I_F=0$, $T_A=100^\circ$ C
Off-state resistance	r_{46}	300			M Ω	$V_{46}=15$ V, $I_F=0$
Capacitance	C_{46}			15	pF	$V_{46}=0$, $I_F=0$, $f=1$ MHz

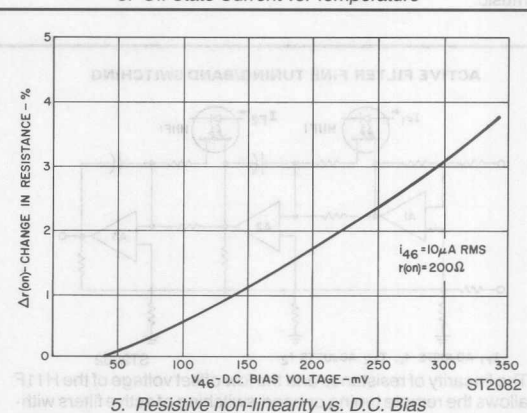
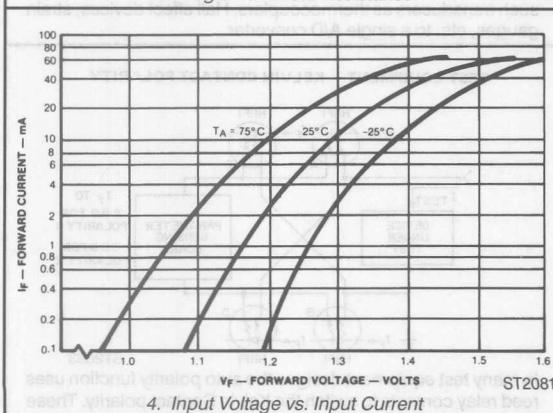
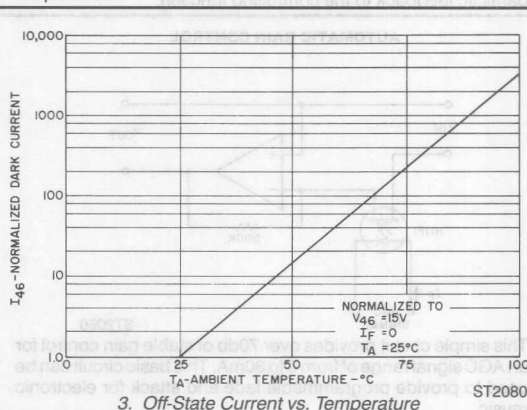
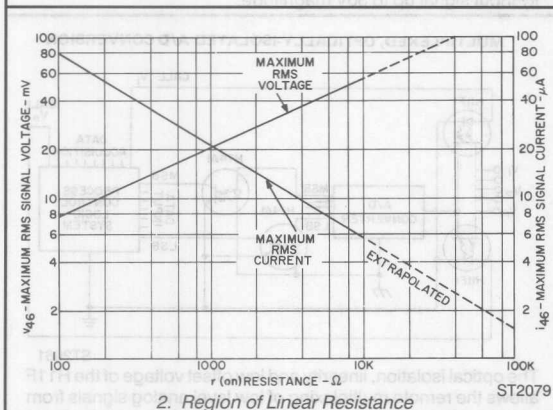
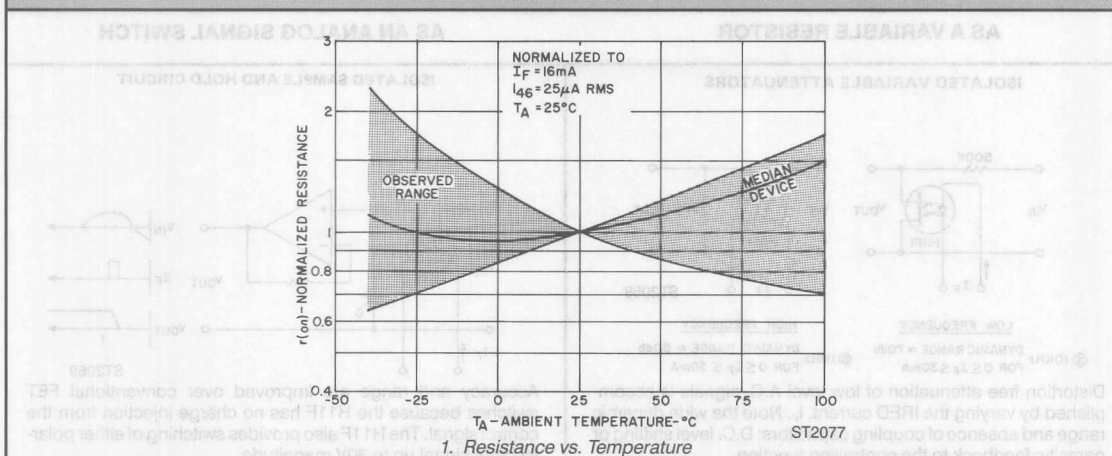
TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
On-state resistance	(H11F1) r_{46}			200	Ω	$I_F=16$ mA, $I_{46}=100$ μ A
	(H11F2) r_{46}			330	Ω	$I_F=16$ mA, $I_{46}=100$ μ A
	(H11F3) r_{46}			470	Ω	$I_F=16$ mA, $I_{46}=100$ μ A
On-state resistance	(H11F1) r_{64}			200	Ω	$I_F=16$ mA, $I_{64}=100$ μ A
	(H11F2) r_{64}			330	Ω	$I_F=16$ mA, $I_{64}=100$ μ A
	(H11F3) r_{64}			470	Ω	$I_F=16$ mA, $I_{64}=100$ μ A
Turn-on time	t_{on}			25	μ s	$I_F=16$ mA, $V_{46}=5$ V, $R_L=50$ Ω
Turn-off time	t_{off}			25	μ s	$I_F=16$ mA, $V_{46}=5$ V, $R_L=50$ Ω
Resistance, non-linearity and asymmetry				0.1	%	$I_F=16$ mA, $R_L=50$ Ω , $V_{46}=5$ V

ISOLATION CHARACTERISTICS

Surge isolation voltage	V_{ISO}	7500			V_{Peak}	1 Minute
Surge isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute
Isolation resistance (input to output)		10^{11}			Ω	$V_{IO}=0$, $f=1$ MHz
Input to output capacitance				2	pF	$V_{IO}=0$, $f=1$ MHz

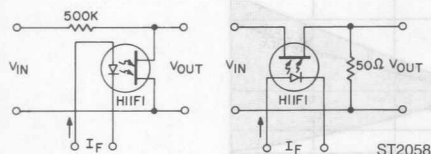
TYPICAL CHARACTERISTICS



TYPICAL APPLICATIONS

AS A VARIABLE RESISTOR

ISOLATED VARIABLE ATTENUATORS



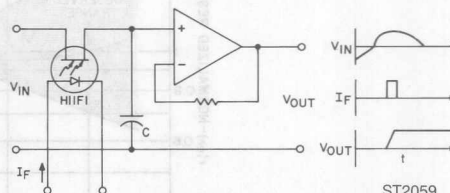
LOW FREQUENCY
@ 10KHz DYNAMIC RANGE $\approx$ 70db
FOR $0 \leq I_F \leq 30\text{mA}$

HIGH FREQUENCY
@ 1MHz DYNAMIC RANGE $\approx$ 50db
FOR $0 \leq I_F \leq 30\text{mA}$

Distortion free attenuation of low level A.C. signals is accomplished by varying the IRED current, I_F . Note the wide dynamic range and absence of coupling capacitors; D.C. level shifting or parasitic feedback to the controlling function.

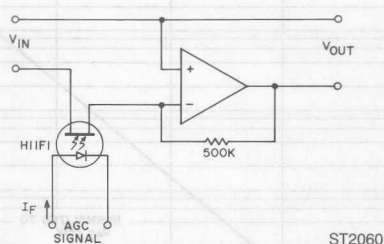
AS AN ANALOG SIGNAL SWITCH

ISOLATED SAMPLE AND HOLD CIRCUIT



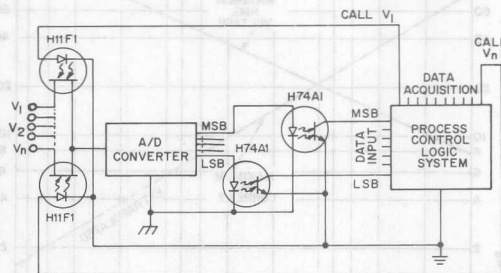
Accuracy and range are improved over conventional FET switches because the H11F has no charge injection from the control signal. The H11F also provides switching of either polarity input signal up to 30V magnitude.

AUTOMATIC GAIN CONTROL



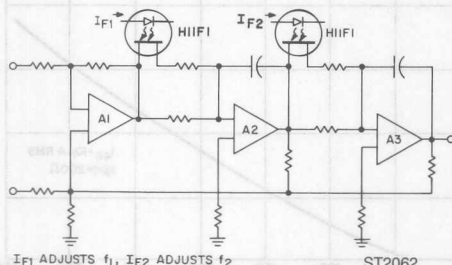
This simple circuit provides over 70db of stable gain control for an AGC signal range of from 0 to 30mA. This basic circuit can be used to provide programmable fade and attack for electronic music.

MULTIPLEXED, OPTICALLY-ISOLATED A/D CONVERSION



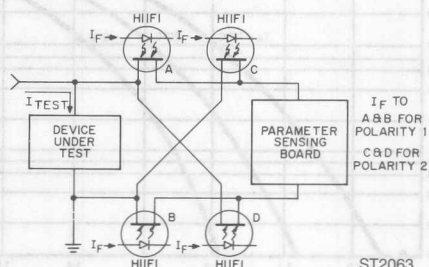
The optical isolation, linearity and low offset voltage of the H11F allows the remote multiplexing of low level analog signals from such transducers as thermocouples, Hall effect devices, strain gauges, etc. to a single A/D converter.

ACTIVE FILTER FINE TUNING/BAND SWITCHING



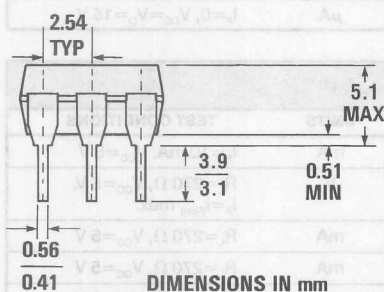
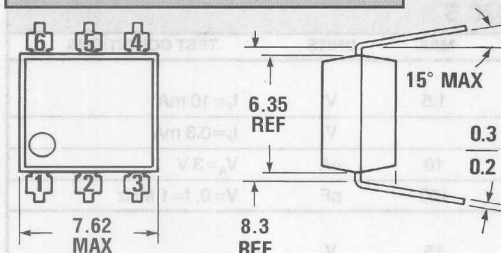
The linearity of resistance and the low offset voltage of the H11F allows the remote tuning or band-switching of active filters without switching glitches or distortion. This schematic illustrates the concept, with current to the H11F1 IRED's controlling the filter's transfer characteristic.

TEST EQUIPMENT - KELVIN CONTACT POLARITY



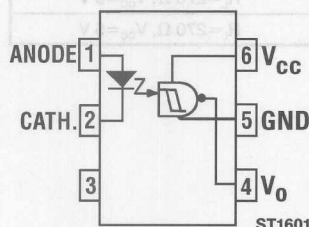
In many test equipment designs the auto polarity function uses reed relay contacts to switch the Kelvin Contact polarity. These reeds are normally one of the highest maintenance cost items due to sticking contacts and mechanical problems. The totally solid-state H11F eliminates these troubles while providing faster switching.

PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**

ST1603



Equivalent Circuit

DESCRIPTION

The H11L series has a medium-to-high speed integrated circuit detector optically coupled to a gallium-arsenide infrared emitting diode. The output incorporates a Schmitt trigger, which provides hysteresis for noise immunity and pulse shaping. The detector circuit is optimized for simplicity of operation and utilizes an open collector output for maximum application flexibility.

FEATURES

- High data rate, 1 MHz typical (NRZ)
- Free from latch up and oscillation throughout voltage and temperature ranges.
- Microprocessor compatible drive
- Logic compatible output sinks 16 mA at 0.4 V maximum
- Guaranteed on/off threshold hysteresis
- High common mode rejection ratio
- Fast switching: $t_r, t_f = 100$ ns typical
- Wide supply voltage capability, compatible with all popular logic systems
- Underwriters Laboratory (UL) recognized — file #E90700

APPLICATIONS

- Logic to logic isolator
- Programmable current level sensor
- Line receiver—eliminate noise and transient problems
- A.C. to TTL conversion—square wave shaping
- Digital programming of power supplies
- Interfaces computers with peripherals

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 150°C
Operating temperature -55°C to 100°C
Lead solder temperature 260°C for 10 sec

INPUT DIODE

Power dissipation (25°C ambient) 100 mW
Derate linearly (above 25°C ambient) ... $1.33 \text{ mW}/^{\circ}\text{C}$
Continuous forward current 60 mA
Peak forward current ($1 \mu\text{s}$ pulse, 300pps) 3 A
Reverse voltage 6 V

DETECTOR

Power dissipation (at 25°C ambient) 150 mW
Derate linearly (above 25°C ambient) $2 \text{ mW}/^{\circ}\text{C}$
 V_{45} allowed range 0 to 16 V
 V_{65} allowed range 0 to 16 V
 I_o output current 50 mA

ELECTRICAL CHARACTERISTICS ($T_A = 0-70^\circ\text{C}$ Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.1	1.5	V	$I_F = 10\text{ mA}$
	V_F	0.75	0.95		V	$I_F = 0.3\text{ mA}$
Reverse current	I_R			10	μA	$V_R = 3\text{ V}$
Capacitance	C_J			100	pF	$V = 0, f = 1\text{ MHz}$
OUTPUT DETECTOR						
Operating voltage range	V_{CC}	3		15	V	
Supply current	$I_{E(Off)}$		1.0	5.0	mA	$I_F = 0, V_{CC} = 5\text{ V}$
Output current, high	I_{OH}			100	μA	$I_F = 0, V_{CC} = V_O = 15\text{ V}$

TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Supply current	$I_{E(on)}$		1.6	5	mA	$I_F = 10\text{ mA}, V_{CC} = 5\text{ V}$
Output voltage, low	V_{OL}		0.2	0.4	V	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}, I_F = I_{F(on)}\text{ max.}$
Turn-on threshold current (H11L1)	$I_{F(on)}$		1.0	1.6	mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
(H11L2)	$I_{F(on)}$		6.0	10.0	mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
(H11L3)	$I_{F(on)}$		3.0	5.0	mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
Turn-off threshold current	$I_{F(off)}$	0.3	1.0		mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
Hysteresis ratio	$I_{F(off)}/I_{F(on)}$	0.50	0.75	0.90		$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$

H11L1 H11L2 H11L3

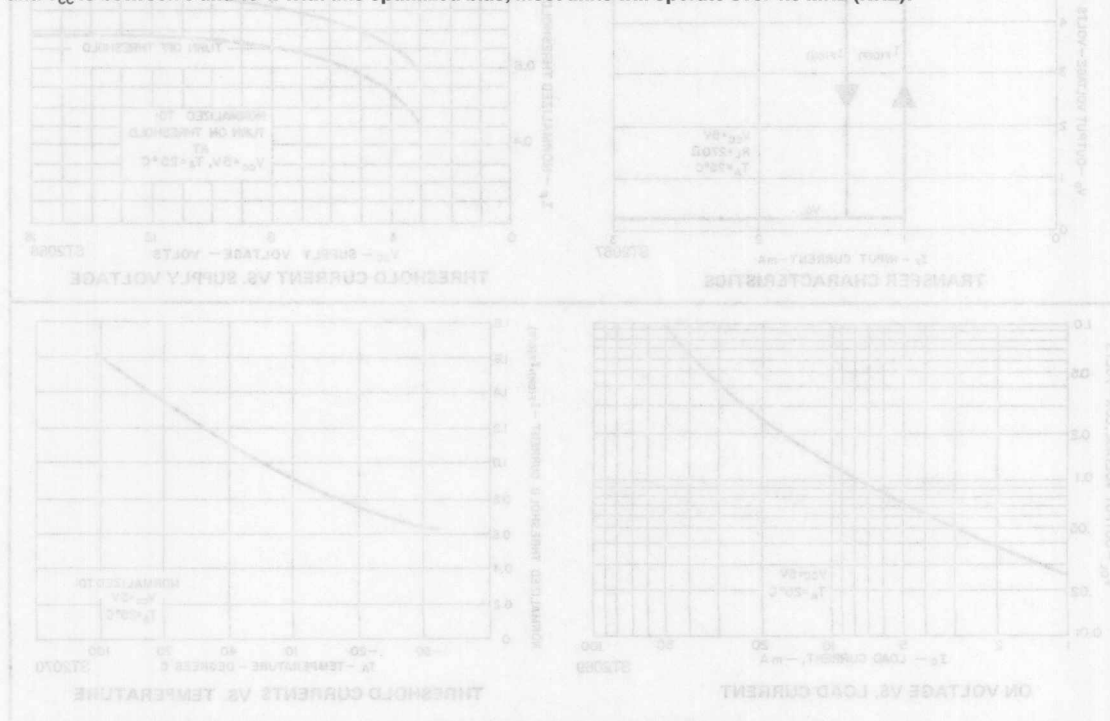
DYNAMIC CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING SPEED						
Turn-on time	t_{ON}		1.0		μS	$C=0, R_E=1.2 k\Omega$
	t_{ON}		0.65		μS	$C=270 pF, R_E=1.2 k\Omega$ $f \leq 100 KHz, t_p \geq 1 \mu s$
Fall time	t_f		0.1		μS	$C=0, R_E=1.2 k\Omega$
	t_f		0.05		μS	$C=270 pF, R_E=1.2 k\Omega$ $f \leq 100 KHz, t_p \geq 1 \mu s$
Turn-off time	t_{OFF}		2.0		μS	$C=0, R_E=1.2 k\Omega$
	t_{OFF}		1.20		μS	$C=270 pF, R_E=1.2 k\Omega$ $f \leq 100 KHz, t_p \geq 1 \mu s$
Rise time	t_r		0.1		μS	$C=0, R_E=1.2 k\Omega$
	t_r		0.07		μS	$C=270 pF, R_E=1.2 k\Omega$ $f \leq 100 KHz, t_p \geq 1 \mu s$
Data rate			1.0*		MHz	

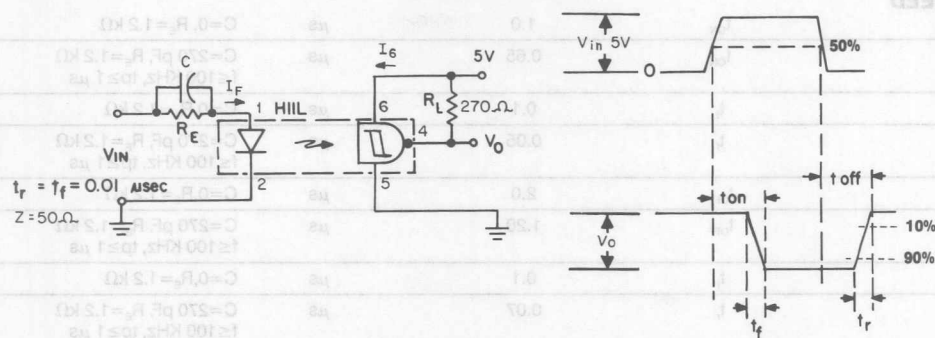
ISOLATION CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Surge isolation voltage	V_{ISO}	7500			V_{PEAK}	1 Minute
Surge isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute

*Maximum data rate will vary depending on the bias conditions and is usually highest when R_E and C are matched to $I_{F(ON)}$ and V_{CC} is between 3 and 15 V. With this optimized bias, most units will operate over 1.5 MHz (NRZ).



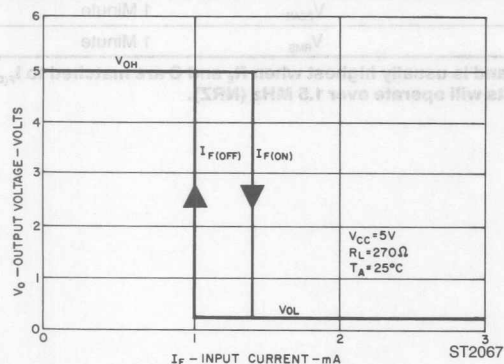
SWITCHING CHARACTERISTICS (25°C) H11L1



ST2066

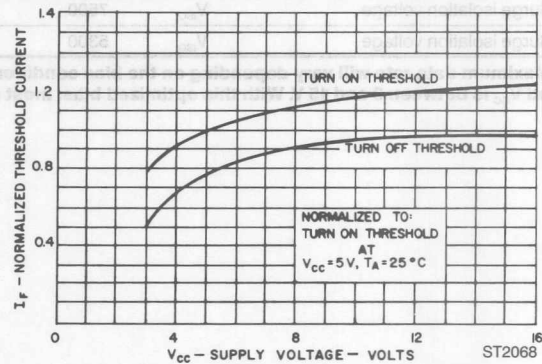
SWITCHING TEST CIRCUIT

TYPICAL CHARACTERISTICS



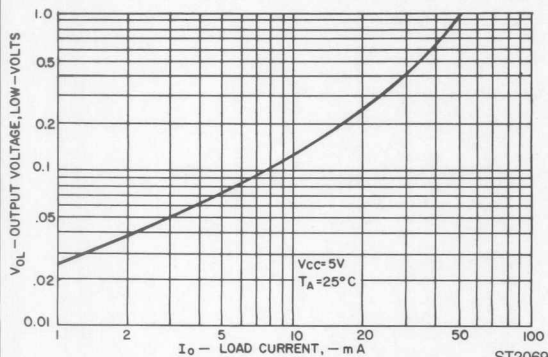
ST2067

TRANSFER CHARACTERISTICS



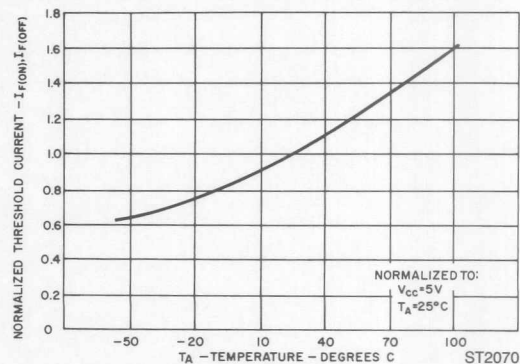
ST2068

THRESHOLD CURRENT VS. SUPPLY VOLTAGE



ST2069

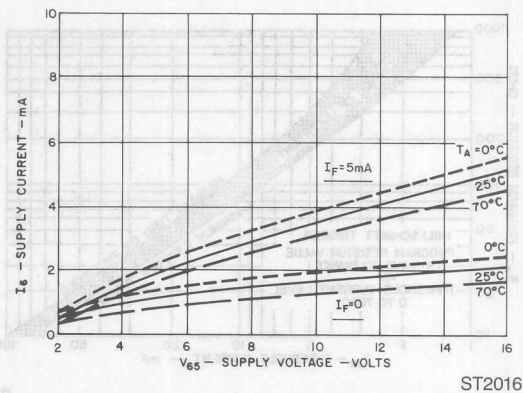
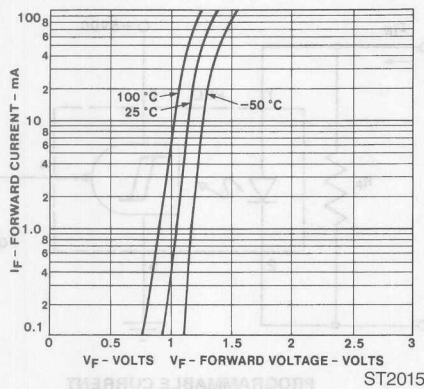
ON VOLTAGE VS. LOAD CURRENT



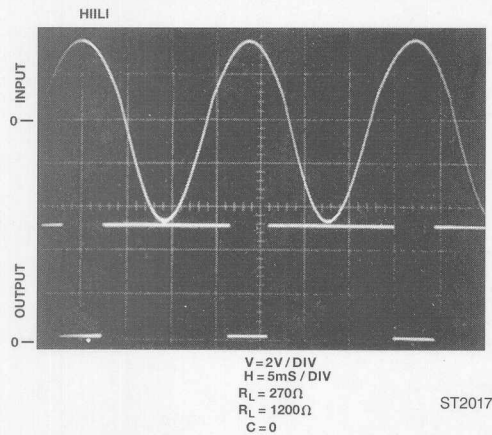
ST2070

THRESHOLD CURRENTS VS. TEMPERATURE

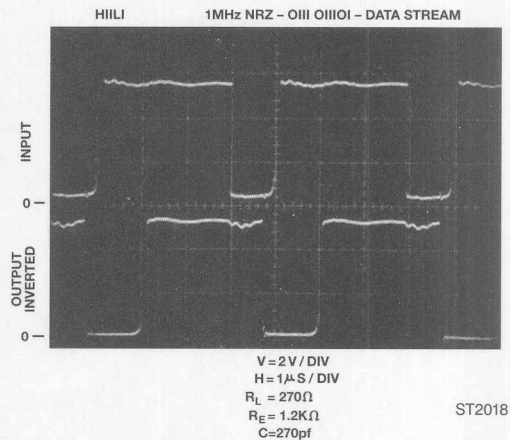
TYPICAL CHARACTERISTICS (Cont'd)



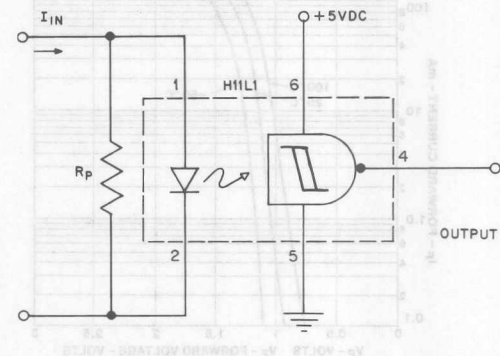
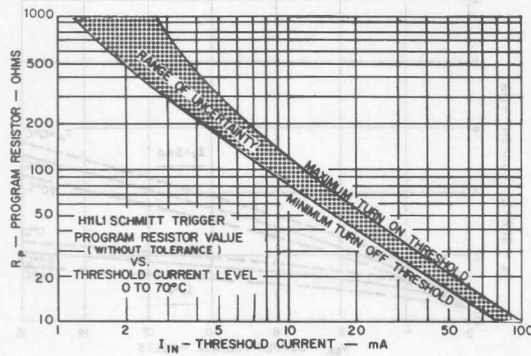
FORWARD VOLTAGE VS. FORWARD CURRENT



SUPPLY CURRENT VS. SUPPLY VOLTAGE

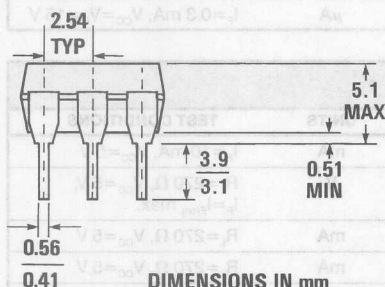
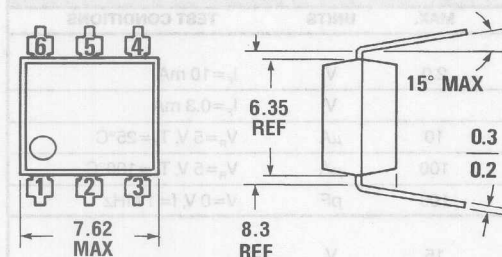


TYPICAL APPLICATION

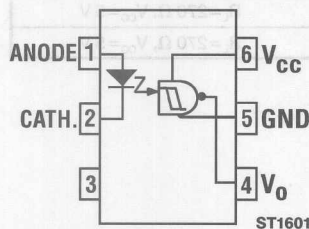


**PROGRAMMABLE CURRENT
THRESHOLD SENSING CIRCUIT**

PACKAGE DIMENSIONS



**DIMENSIONS IN mm
PACKAGE CODE E**



Equivalent Circuit

DESCRIPTION

The H11N series has a medium-to-high speed integrated circuit detector optically coupled to a gallium-aluminum-arsenide infrared emitting diode. The output incorporates a Schmitt trigger, which provides hysteresis for noise immunity and pulse shaping. The detector circuit is optimized for simplicity of operation and utilizes an open collector output for maximum application flexibility.

FEATURES & APPLICATIONS

- High data rate, 5 MHz typical (NRZ)
- Free from latch up and oscillation throughout voltage and temperature ranges
- Microprocessor compatible drive
- Logic compatible output sinks 16 mA at 0.5 V maximum
- Guaranteed on/off threshold hysteresis
- High common mode transient immunity 2000 V/ μ s minimum
- Fast switching: t_r , t_f = 10 ns typical
- Wide supply voltage capability, compatible with all popular logic systems
- Underwriters Laboratory (UL) recognized — file #E90700
- Logic to logic isolator
- Programmable current level sensor
- Line receiver—eliminates noise and transient problems
- Logic level shifter—couples TTL to CMOS
- A.C. to TTL conversion—square wave shaping
- Isolated power MOS driver for power supplies
- Interfaces computers with peripherals

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 125°C
Operating temperature -25°C to 85°C
Lead solder temperature 260°C for 10 sec

INPUT DIODE

Power dissipation (25°C ambient) 50 mW
Derate linearly (above 70°C) 1.67 mW/ $^{\circ}\text{C}$
Continuous forward current 30 mA
Peak forward current
(300 μ s pulse, 2% duty cycle) 50 mA
Reverse voltage 6 V

DETECTOR

Power dissipation (at 25°C ambient) 150 mW
Derate linearly (above 25°C ambient) 5 mW/ $^{\circ}\text{C}$
 V_{45} allowed range 0 to 16 V
 V_{65} allowed range 0 to 16 V
 I_4 output current 50 mA

ELECTRICAL CHARACTERISTICS ($T_A = 0-70^\circ\text{C}$ Unless Otherwise Specified) Note 1

INDIVIDUAL COMPONENT CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.6	2.0	V	$I_F = 10\text{ mA}$
	V_F	0.75	1.45		V	$I_F = 0.3\text{ mA}$
Reverse current	I_R			10	μA	$V_R = 5\text{ V}, T_A = 25^\circ\text{C}$
	I_R			100	μA	$V_R = 5\text{ V}, T_A = 100^\circ\text{C}$
Capacitance	C_i			100	pF	$V = 0\text{ V}, f = 1\text{ MHz}$
OUTPUT DETECTOR						
Operating voltage range	V_{CC}	4		15	V	
Supply current	$I_{B(off)}$		5.5	10	mA	$I_F = 0, V_{CC} = 5\text{ V}$
Output current, high	I_{OH}			100	μA	$I_F = 0.3\text{ mA}, V_{CC} = V_O = 15\text{ V}$

TRANSFER CHARACTERISTICS ($T_A = 0-70^\circ\text{C}$) Note 1

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Supply current	$I_{B(on)}$		5	10	mA	$I_F = 10\text{ mA}, V_{CC} = 5\text{ V}$
Output voltage, low	V_{OL}		0.3	0.5	V	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}, I_F = I_{F(on)}\text{ max.}$
Turn-on threshold current	(H11N1) $I_{F(on)}$	0.8		3.2	mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
	(H11N2) $I_{F(on)}$	2.3		5.0	mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
	(H11N3) $I_{F(on)}$	4.1		10.0	mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
Turn-off threshold current	$I_{F(off)}$	0.3	1.5		mA	$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$
Hysteresis ratio	$I_{F(off)}/I_{F(on)}$	0.65	0.8	0.95		$R_L = 270\ \Omega, V_{CC} = 5\text{ V}$

DYNAMIC CHARACTERISTICS ($T_A = 0-70^\circ\text{C}$) Note 1

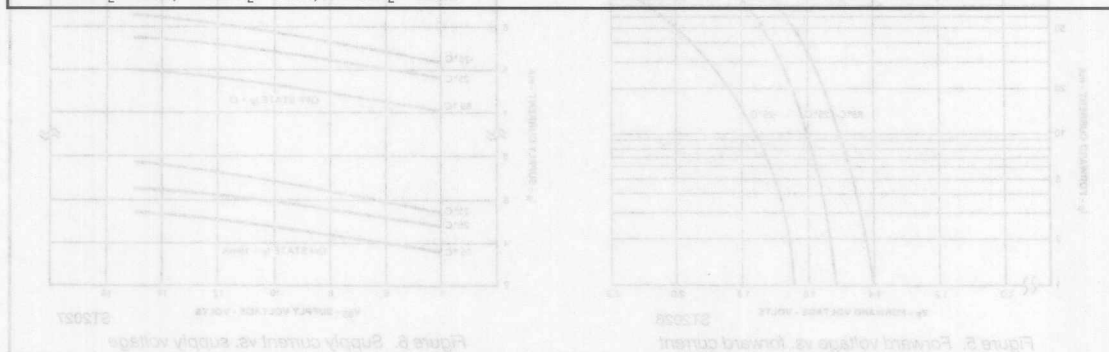
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
SWITCHING SPEED (Figures 7&8)						
Propagation delay, high to low	t_{PHL}		150	330	ns	$C=120\text{ pF}$, $t_p=1\text{ }\mu\text{s}$, R_E : Note 4
Rise time	t_r		10		ns	$C=120\text{ pF}$, $t_p=1\text{ }\mu\text{s}$, R_E : Note 4
Propagation delay, low to high	t_{PLH}		150	330	ns	$C=120\text{ pF}$, $t_p=1\text{ }\mu\text{s}$, R_E : Note 4
Fall time	t_f		15		ns	$C=120\text{ pF}$, $t_p=1\text{ }\mu\text{s}$, R_E : Note 4
Data rate			5		MHz	Note 3
OVERDRIVE SWITCHING (FIGURES 7&8), NOTE 2						
Turn-off time	t_{off}		0.2	0.5	μs	$C=0$, $R_i=270\text{ }\Omega$, $I_F(\text{MAX})$ H11N1: 5 mA H11N2: 10 mA H11N3: 20 mA
TRANSIENT IMMUNITY (FIGURE 9)						
Common mode transient immunity	CM_H	± 2000	± 10000		V/ μs	$V_{pk}=50\text{ V}$, $V_{CC}=5\text{ V}$, $R_L=270\text{ }\Omega$, $I_F=0$
Common mode transient immunity	CM_L	± 2000	± 10000		V/ μs	$V_{pk}=50\text{ V}$, $V_{CC}=5\text{ V}$, $R_L=270\text{ }\Omega$, $I_F=0$

ISOLATION CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Surge isolation voltage	V_{ISO}	7500			V_{PEAK}	1 Minute
Surge isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute

Notes

1. All measurements are with 100nF bypass capacitor from pin 6 to pin 5.
2. Steady overdrive increases t_{off} . Use of a large R_E and a small C as in figure 7 is preferred over overdrive current.
3. Maximum data rate will vary depending on the bias conditions and is usually highest when R_E and C are matched to $I_{F(ON)}$ and V_{CC} is between 5 and 15V. With this optimized bias, most units will operate at over 10 MHz, NRZ.
4. H11N1: $R_E = 910\Omega$, H11N2: $R_E = 560\Omega$, H11N3: $R_E = 240\Omega$.



TYPICAL CHARACTERISTICS

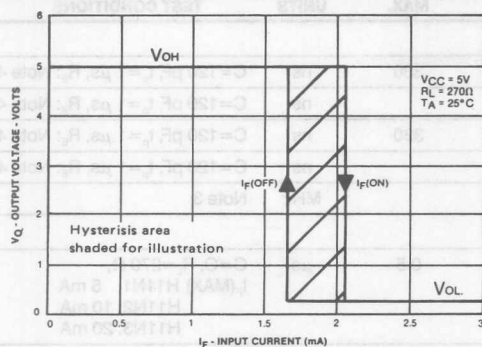


Figure 1. Transfer characteristics ST2022

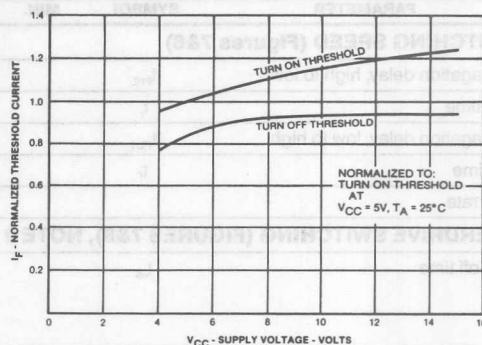


Figure 2. Threshold current vs. supply voltage ST2023

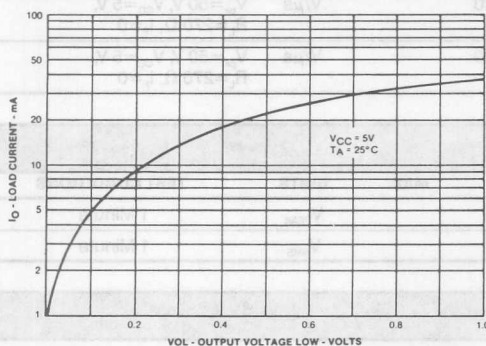


Figure 3. ON voltage vs. current ST2024

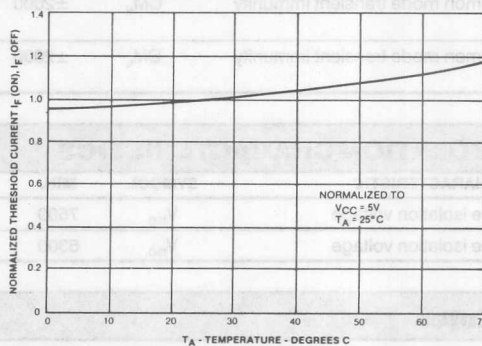


Figure 4. Threshold current vs. temperature ST2025

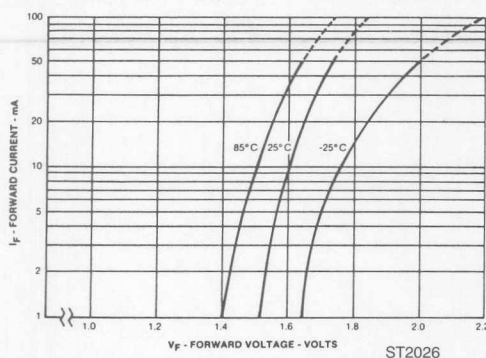


Figure 5. Forward voltage vs. forward current ST2026

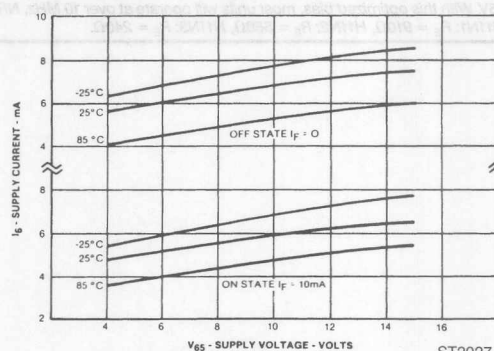
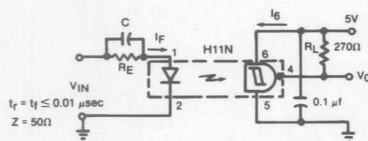


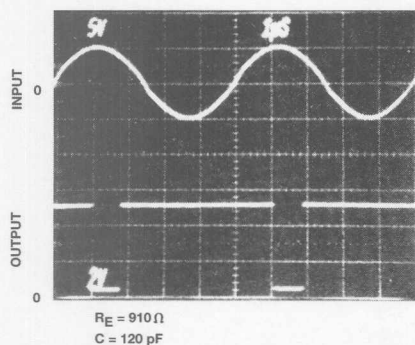
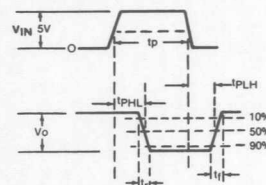
Figure 6. Supply current vs. supply voltage ST2027

TYPICAL CHARACTERISTICS



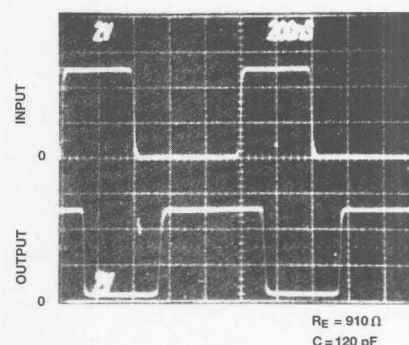
ST2028

Figure 7. Switching test circuit

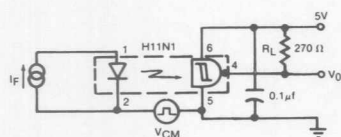


ST2029

Figure 8. Switching test waveforms

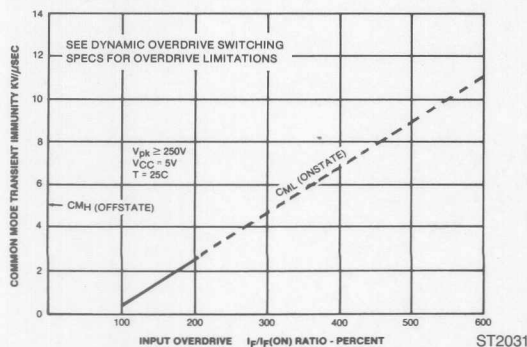
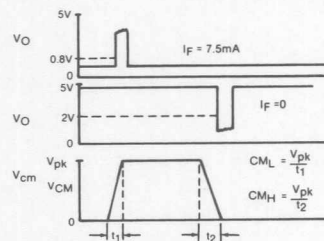


R_E = 910 Ω
C = 120 pF



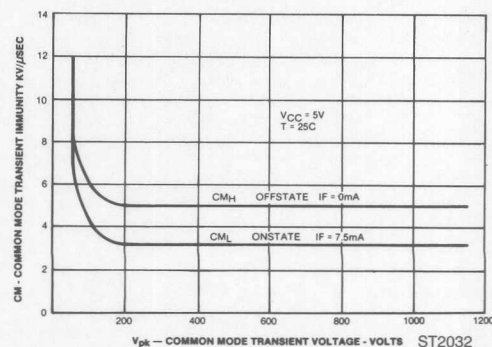
ST2030

Figure 9. Common-mode transient immunity, test circuit and voltage waveforms



ST2031

Figure 10. CM_L and CM_H input current



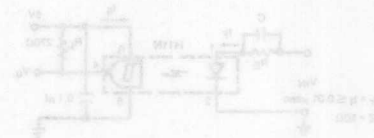
ST2032

Figure 11. CM_L and CM_H vs. common-mode transient voltage

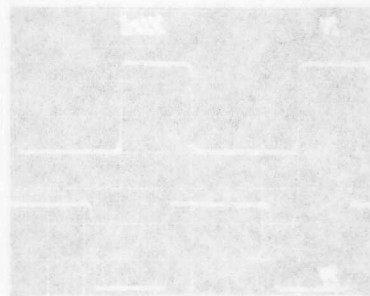
TYPICAL CHARACTERISTICS



Figure 7. Switching test circuit



ST5028


 $t_p = 100 \mu s$
 $T = 100 \mu s$

ST5028

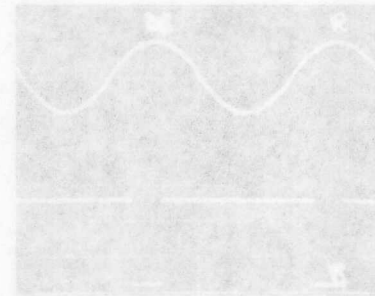

 $t_p = 100 \mu s$
 $T = 100 \mu s$

Figure 8. Common-mode transient immunity test waveform

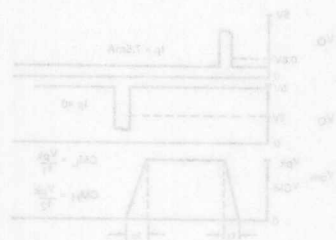
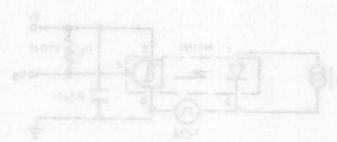


Figure 9. Common-mode transient immunity test circuit and voltage waveforms



ST5028

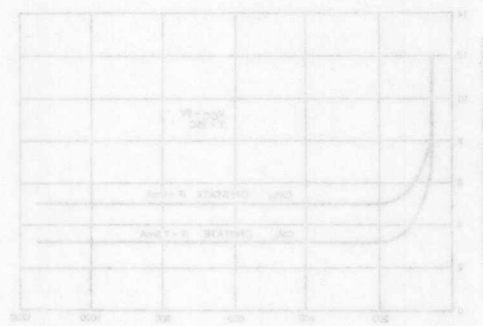


Figure 11. CM and CM vs. common-mode transient voltage

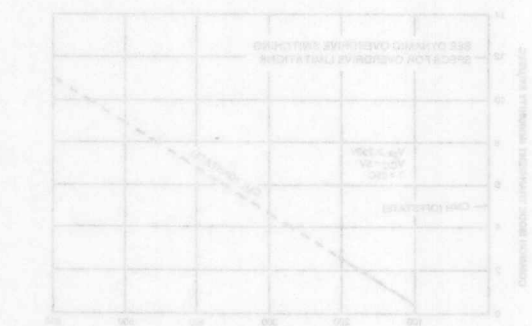
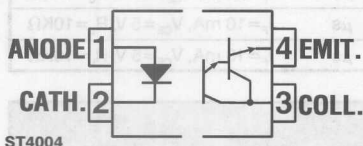
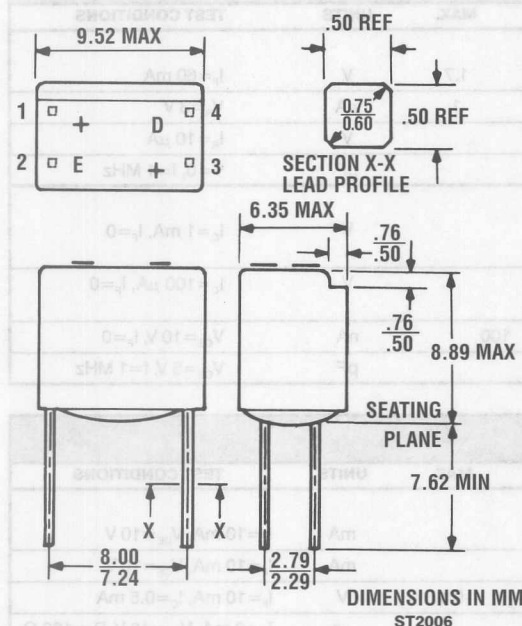


Figure 10. CM and CM front current

PACKAGE DIMENSIONS



Equivalent Circuit

DESCRIPTION

The H24A series consists of a gallium arsenide infrared emitting diode coupled with a silicon phototransistor. The devices are housed in a low-cost plastic package with lead spacing compatible with a dual in-line package.

FEATURES

- 4-pin configuration
- Small package size and low cost
- UL recognized-file E51868

APPLICATIONS

- Digital logic inputs
- Microprocessor inputs
- Industrial controls

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 85°C
Operating temperature -55°C to 85°C
Lead solder temperature 260°C for 5 sec

INPUT DIODE

Power dissipation (25°C ambient) 100 mW
Derate linearly (above 25°C) 1.67 mW/°C
Continuous forward current 60 mA
Reverse voltage 4 V

DETECTOR

Power dissipation (25°C ambient) 150 mW
Derate linearly (above 25°C) 2.5 mW/°C
 V_{CEO} 30 V
 V_{ECO} 6 V
Continuous forward current 100 mA

ELECTRICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F			1.7	V	$I_F=60$ mA
Reverse current	I_R			1	μ A	$V_R=3$ V
Reverse breakdown voltage	$V_{(BR)R}$	4			V	$I_R=10$ μ A
Capacitance	C_J		30		pF	$V=0$, $f=1$ MHz
OUTPUT DETECTOR						
Breakdown voltage Collector to emitter	BV_{CEO}	30			V	$I_C=1$ mA, $I_F=0$
Breakdown voltage Emitter to Collector	BV_{ECO}	7			V	$I_C=100$ μ A, $I_F=0$
Collector dark current	I_{CEO}		5	100	nA	$V_{CE}=10$ V, $I_F=0$
Capacitance	C_{CE}		3.3		pF	$V_{CE}=5$ V, $f=1$ MHz

TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC CURRENT TRANSFER RATIO						
H24A1	I_C	10.0			mA	$I_F=10$ mA, $V_{CE}=10$ V
H24A2	I_C	2.0			mA	$I_F=10$ mA, $V_{CE}=10$ V
Saturation voltage	$V_{CE(SAT)}$		0.1	0.4	V	$I_F=10$ mA, $I_C=0.5$ mA
Turn-on time	t_{on}		9		μ s	$I_C=2$ mA, $V_{CE}=10$ V, $R_L=100$ Ω
Turn-off time	t_{off}		4		μ s	$I_F=2$ mA, $V_{CE}=10$ V, $R_L=100$ Ω
Turn-on time	t_{on}		6.5		μ s	$I_F=10$ mA, $V_{CE}=5$ V, $R_L=10K\Omega$
Turn-off time	t_{off}		165		μ s	$I_F=10$ mA, $V_{CE}=5$ V, $R_L=10K\Omega$

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Surge isolation voltage	V_{ISO}	6000			V_{Peak}	1 Minute
Steady-state isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{I-O}=500$ VDC
Isolation capacitance	C_{ISO}		0.5		pF	$V_{I-O}=0$, $f=1$ MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

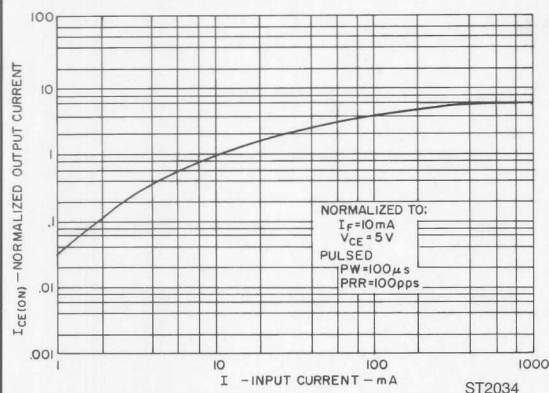


Fig. 1. Output Current vs. Input Current

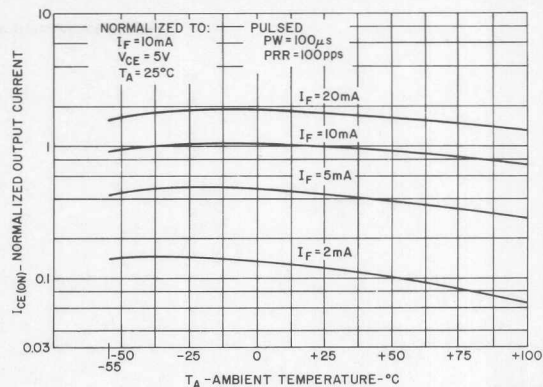


Fig. 2. Output Current vs. Temperature

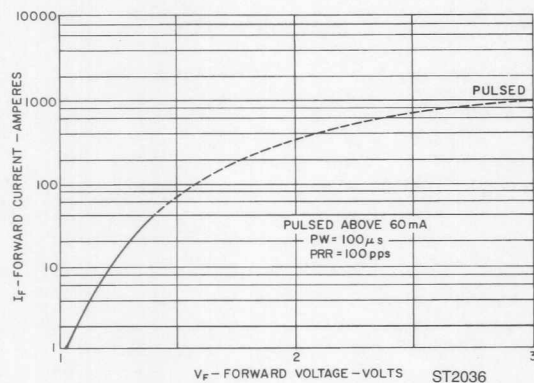


Fig. 3. Input Characteristics

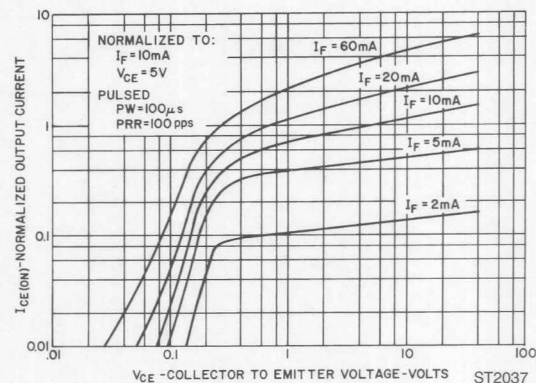


Fig. 4. Output Characteristics

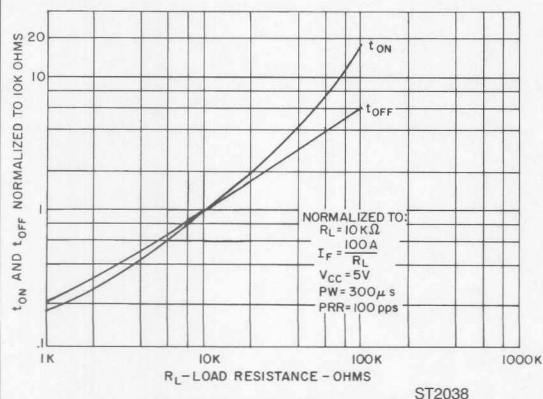


Fig. 5. Switching Speed vs. R_L

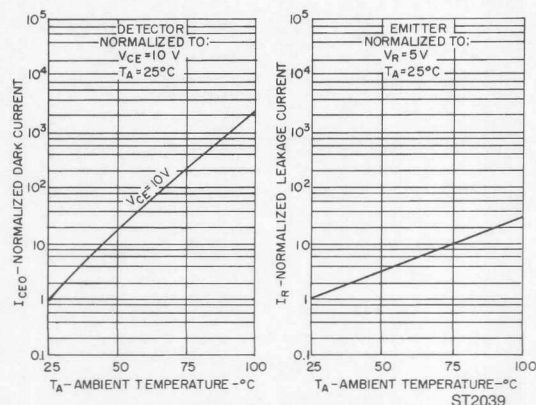


Fig. 6. Leakage Current vs. Temperature

TYPICAL ELECTRICAL CHARACTERISTIC CURVES ST5030 - PNP Silicon Power Transistor

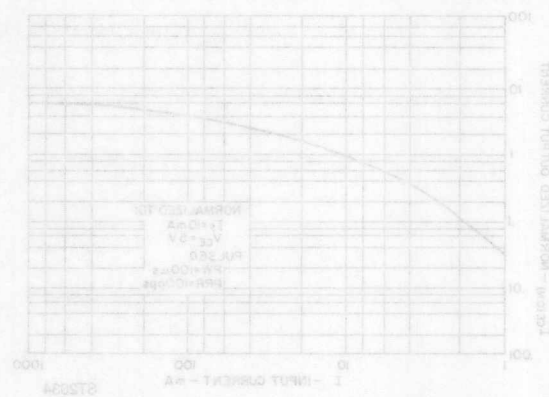


Fig. 1. Output Current vs. Input Current

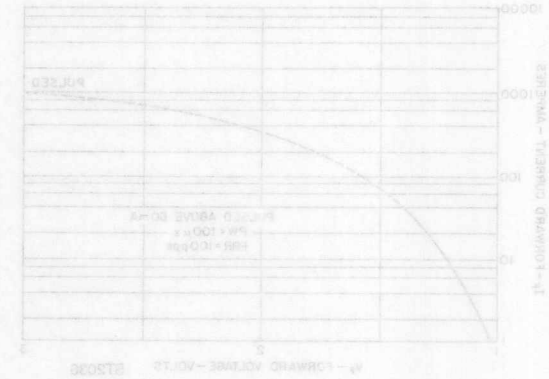


Fig. 3. Input Characteristics

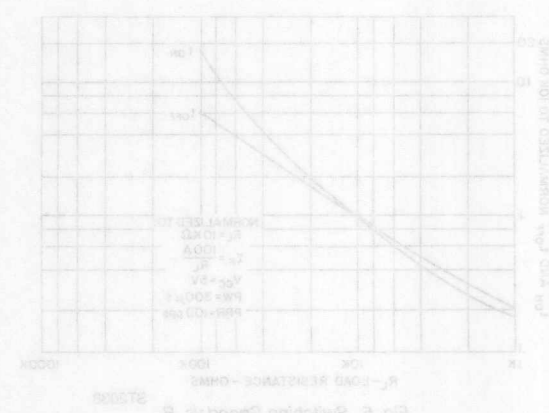


Fig. 2. Switching Speed vs. R_L

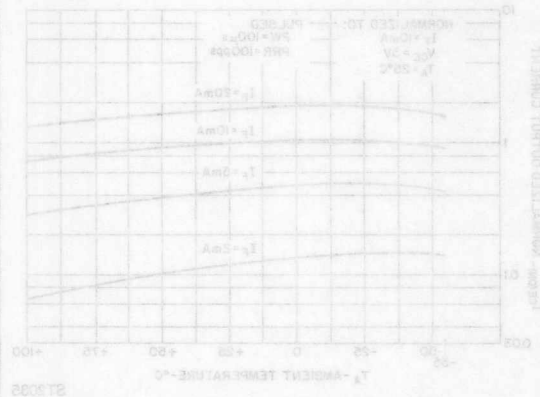


Fig. 5. Output Current vs. Temperature



Fig. 4. Output Characteristics

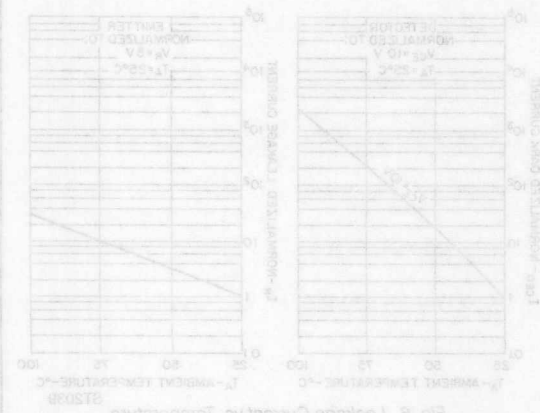
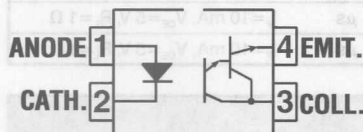
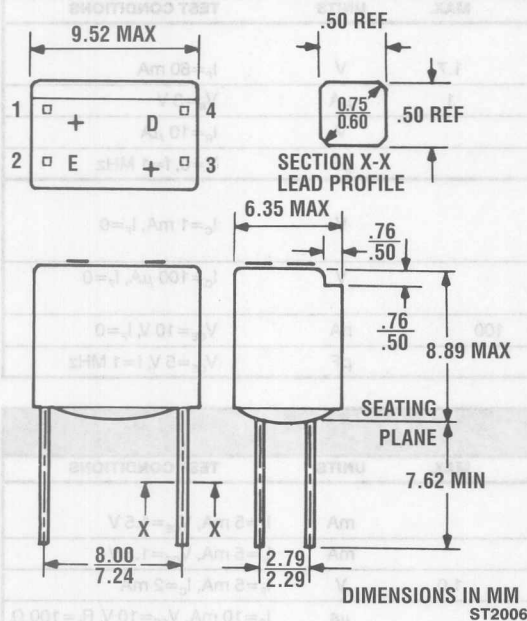


Fig. 6. Leakage Current vs. Temperature

PACKAGE DIMENSIONS



ST4004

Equivalent Circuit

DESCRIPTION

The H24B series consists of a gallium arsenide infrared emitting diode coupled with a silicon phototransistor. The devices are housed in a low-cost plastic package with lead spacing compatible with a dual in-line package.

FEATURES

- 4-pin configuration
- Small package size and low cost
- UL recognized-file E51868
- High current transfer ratio

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature -55°C to 85°C
Operating temperature -55°C to 85°C
Lead solder temperature 260°C for 5 sec

INPUT DIODE

Power dissipation (25°C ambient) 100 mW
Derate linearly (above 25°C) 1.67 mW/°C
Continuous forward current 60 mA
Peak forward current (1 μ s pulse, 300pps) 3 A
Reverse voltage 4 V

DETECTOR

Power dissipation (at 25°C ambient) 150 mW
Derate linearly (above 25°C ambient) 2.5 mW/°C
 V_{CEO} 30 V
 V_{ECO} 7 V
Continuous forward current 100 mA

ELECTRICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F			1.7	V	$I_F=60$ mA
Reverse current	I_R			1	μ A	$V_R=3$ V
Reverse breakdown voltage	$V_{(BR)R}$	4			V	$I_R=10$ μ A
Capacitance	C_J		30		pF	$V=0$, $f=1$ MHz
OUTPUT DETECTOR						
Breakdown voltage Collector to emitter	BV_{CEO}	30			V	$I_C=1$ mA, $I_F=0$
Breakdown voltage Emitter to Collector	BV_{ECO}	7			V	$I_C=100$ μ A, $I_F=0$
Collector dark current	I_{CEO}		5	100	nA	$V_{CE}=10$ V, $I_F=0$
Capacitance	C_{CE}		5		pF	$V_{CE}=5$ V, $f=1$ MHz

TRANSFER CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
DC CURRENT TRANSFER RATIO						
H24B1	I_C	50.0			mA	$I_F=5$ mA, $V_{CE}=1.5$ V
H24B2	I_C	20.0			mA	$I_F=5$ mA, $V_{CE}=1.5$ V
Saturation voltage	$V_{CE(SAT)}$		0.8	1.0	V	$I_F=5$ mA, $I_C=2$ mA
Turn-on time	t_{on}		105		μ s	$I_C=10$ mA, $V_{CE}=10$ V, $R_L=100$ Ω
Turn-off time	t_{off}		60		μ s	$I_F=10$ mA, $V_{CE}=10$ V, $R_L=100$ Ω
Turn-on time	t_{on}		10		μ s	$I_F=10$ mA, $V_{CE}=5$ V, $R_L=1$ Ω
Turn-off time	t_{off}		700		μ s	$I_F=10$ mA, $V_{CE}=5$ V, $R_L=1$ Ω

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Surge isolation voltage	V_{ISO}	6000			V_{Peak}	1 Minute
Steady-state isolation voltage	V_{ISO}	5300			V_{RMS}	1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{I/O}=500$ VDC
Isolation capacitance	C_{ISO}		0.5		pF	$V_{I/O}=0$, $f=1$ MHz

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

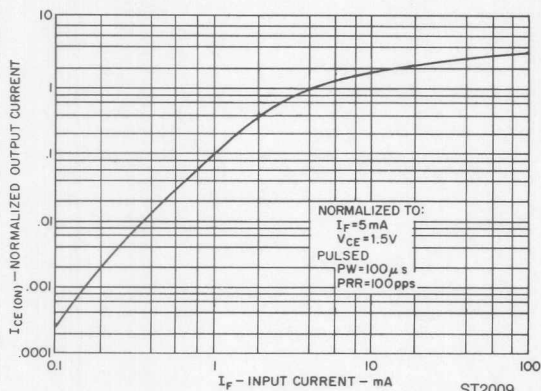


Fig. 1. Output Current vs. Input Current

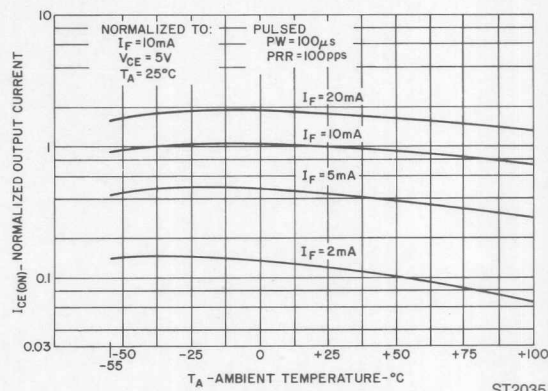


Fig. 2. Output Current vs. Temperature

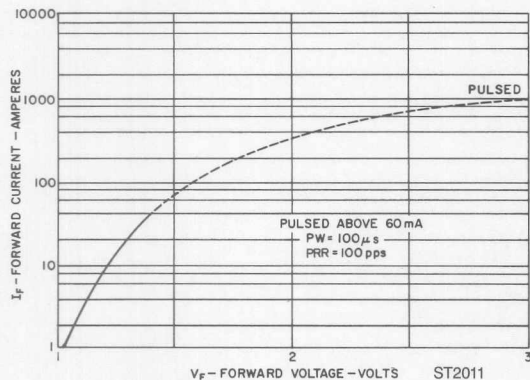


Fig. 3. Input Characteristics

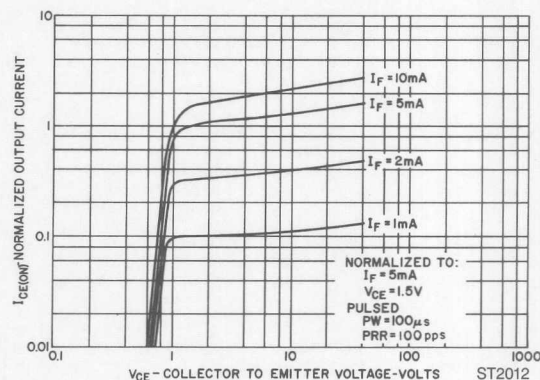


Fig. 4. Output Characteristics

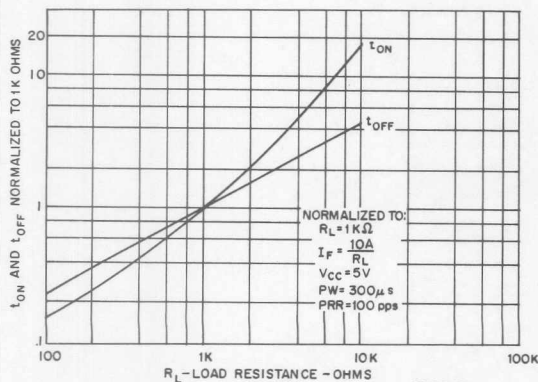


Fig. 5. Switching Speed vs. R_L

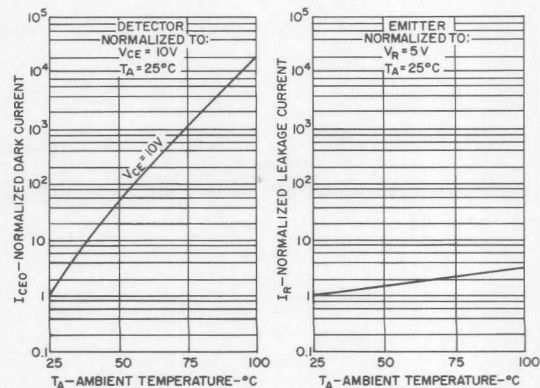


Fig. 6. Leakage Current vs. Temperature

Fig. 1 Output Current vs. Input Current

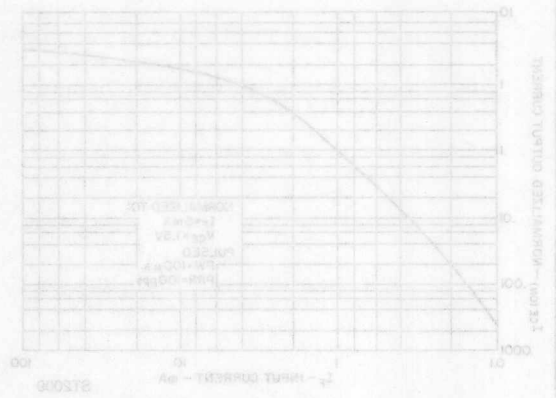


Fig. 2 Output Current vs. Temperature

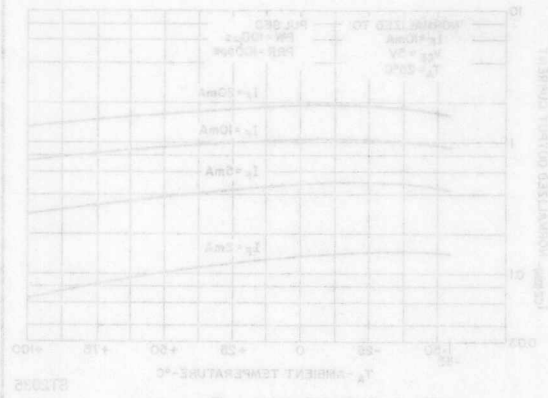


Fig. 3 Input Characteristics

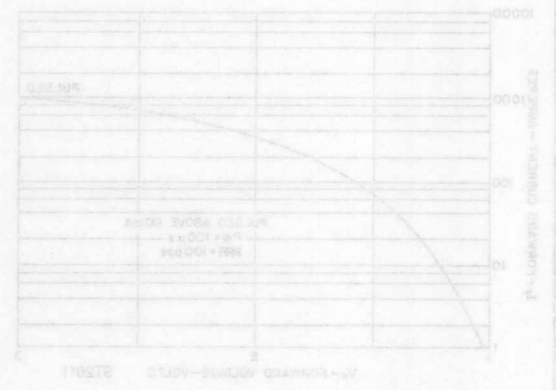


Fig. 4 Output Characteristics

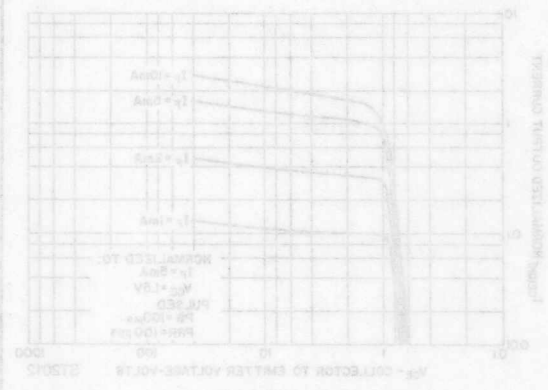


Fig. 5 Switching Speed vs. R_L

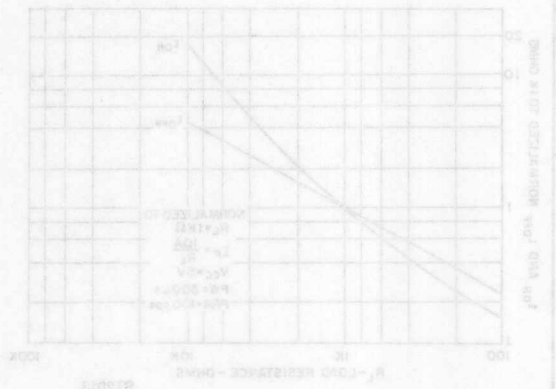
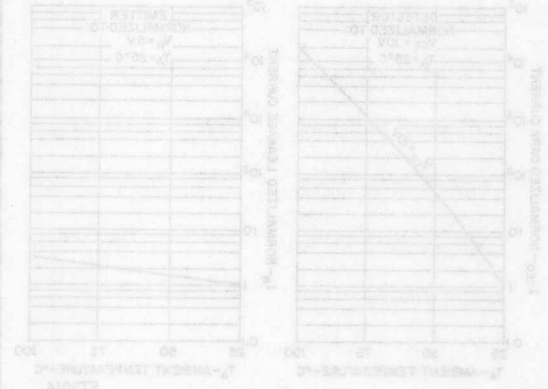
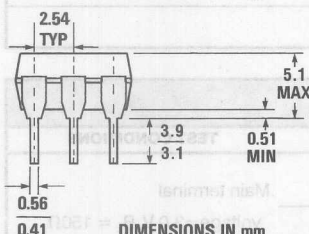
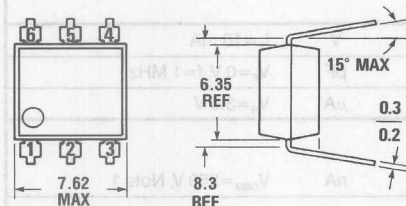


Fig. 6 Leakage Current vs. Temperature

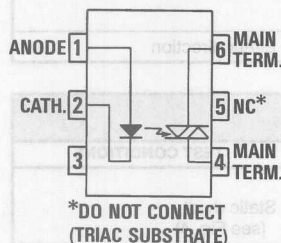


PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE E

ST1603-02



Equivalent Circuit

C2081

DESCRIPTION

The MOC3009, MOC3010, MOC3011 and MOC3012 are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. This series is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 120 VAC operations.

FEATURES

- Low input current required (typically 5mA—MOC3011)
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized—File E90700

APPLICATIONS

- Triac driver
- Industrial controls
- Traffic lights
- Vending machines
- Motor control
- Solid state relay

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−40°C to 100°C
Lead temperature (soldering 10 sec)	260°C
Withstand test voltage	7500 VAC Peak (50-60 Hz)

INPUT DIODE

Forward DC current	50 mA
Reverse voltage	3 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation (25°C ambient)	100 mW
Derate linearly (above 25°C)	1.33 mW/°C

OUTPUT DRIVER

Off-state output terminal voltage	250 volts
On-state RMS current $T_A=25^\circ\text{C}$	100 mA
(Full cycle, 50 to 60 Hz) $T_A=70^\circ\text{C}$	50 mA
Peak nonrepetitive surge current (PW=10 ms, DC=10%)	1.2 A
Total power dissipation @ $T_A=25^\circ\text{C}$	300 mW
Derate above 25°C	4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)**INDIVIDUAL COMPONENT CHARACTERISTICS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F	1.2	1.50		V	$I_F = 10 \text{ mA}$
Junction capacitance	C_J	50			pF	$V_F = 0 \text{ V}, f = 1 \text{ MHz}$
Reverse leakage current	I_R			100	μA	$V_R = 3.0 \text{ V}$
OUTPUT DETECTOR						
Peak blocking current, either direction	I_{DRM}	—		100	nA	$V_{DRM} = 250 \text{ V}$, Note 1
Peak on-state voltage, either direction	V_{TM}	—	2.0	3.0	Volts	$I_{TM} = 100 \text{ mA}$ Peak

Note 1. Test voltage must be applied within dv/dt rating.

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
LED trigger current (current required to latch output)	MOC3009 I_{FT}	—	15.0	30	mA	Main terminal
	MOC3010 I_{FT}	—	10.0	15	mA	voltage = 3.0 V, $R_L = 150\Omega$
	MOC3011 I_{FT}	—	5	10	mA	
	MOC3012 I_{FT}	—	—	5	mA	
Holding current	I_H	—	100	—	μA	Either direction

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
AC dv/dt RATING						
Critical rate of rise of off-state voltage	dv/dt	—	12.0	—	V/ μs	Static dv/dt (see Fig. 4)
Critical rate of rise of commutating voltage	dv/dt	—	0.2	—	V/ μs	Commutating dv/dt $I_{LOAD} = 15 \text{ mA}$ (see Fig. 4)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{ISO}	5300			$V_{AC,RMS}$	$I_{IO} \leq 1 \mu\text{A}$, 1 Minute
	V_{ISO}	7500			$V_{AC,PEAK}$	$I_{IO} \leq 1 \mu\text{A}$, 1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{IO} = 500 \text{ VDC}$
Isolation capacitance	C_{ISO}		0.5		pF	$f = 1 \text{ MHz}$

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

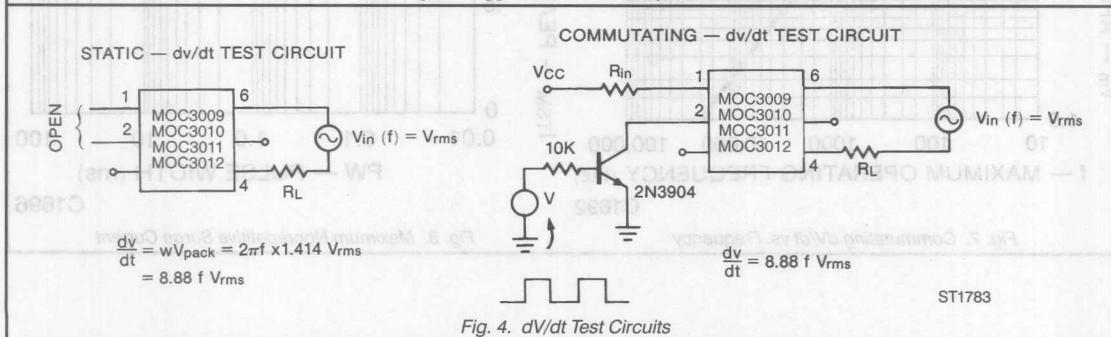
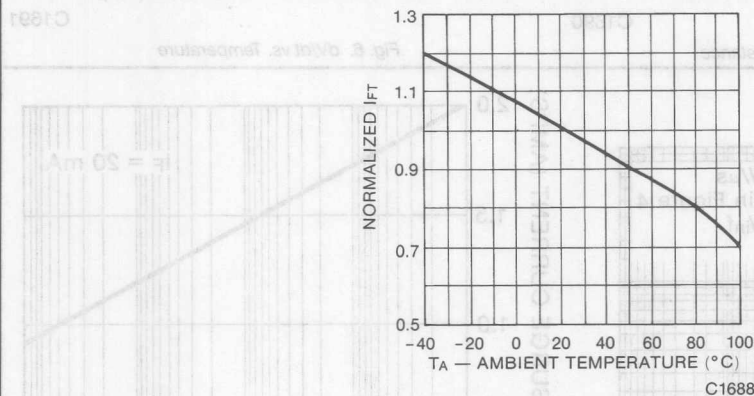
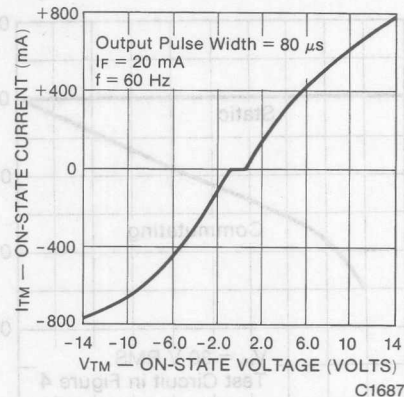
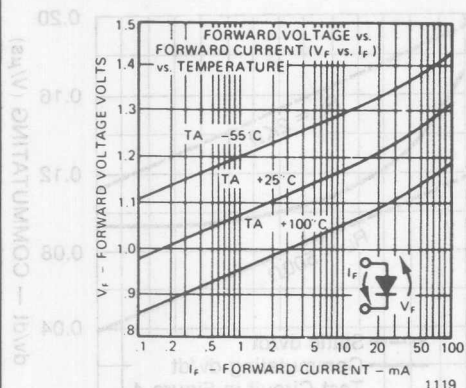
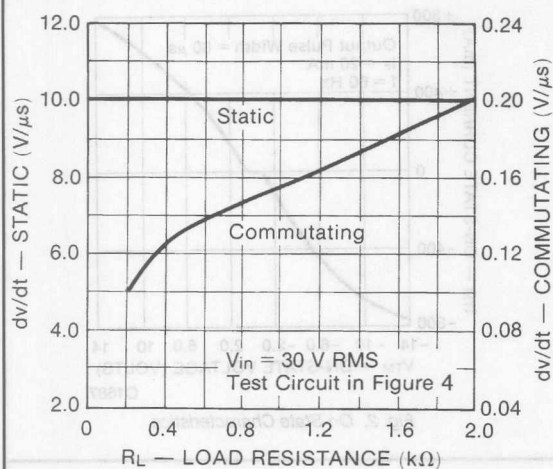


Fig. 4. dV/dt Test Circuits

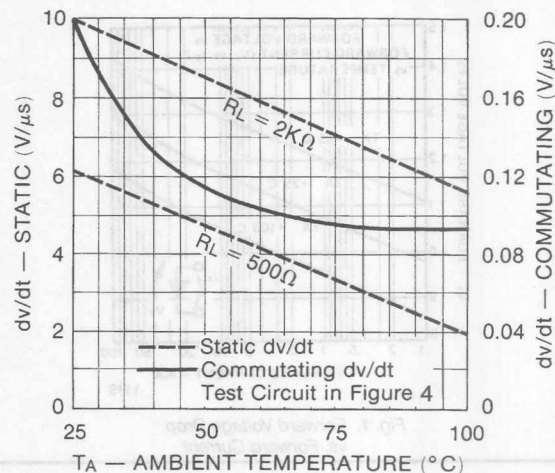
TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



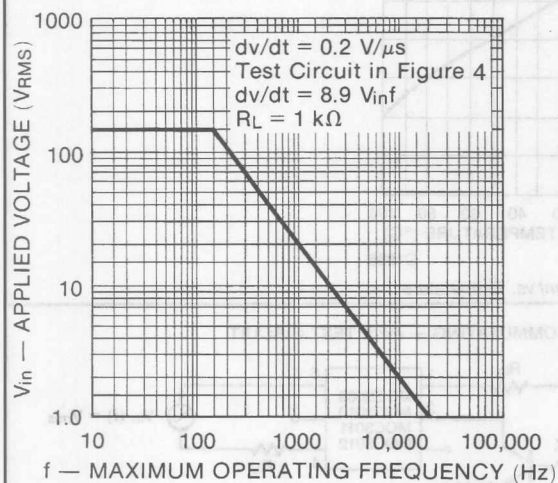
C1690

Fig. 5. dv/dt vs. Load Resistance



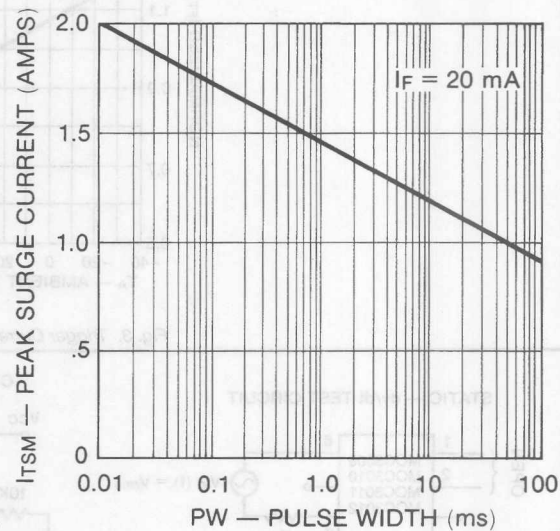
C1691

Fig. 6. dv/dt vs. Temperature



C1692

Fig. 7. Commutating dv/dt vs. Frequency



C1696

Fig. 8. Maximum Nonrepetitive Surge Current

TYPICAL APPLICATION CIRCUITS

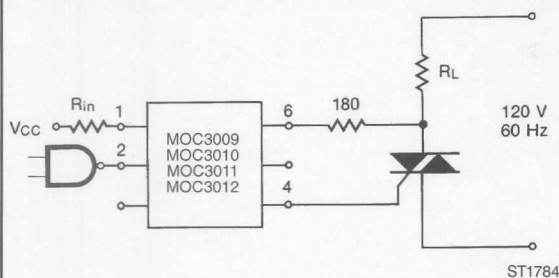


Fig. 9. Resistive Load

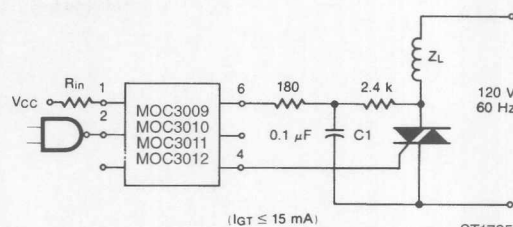


Fig. 10. Inductive Load With Sensitive Gate Triac

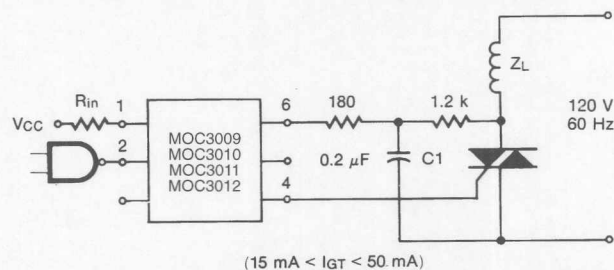
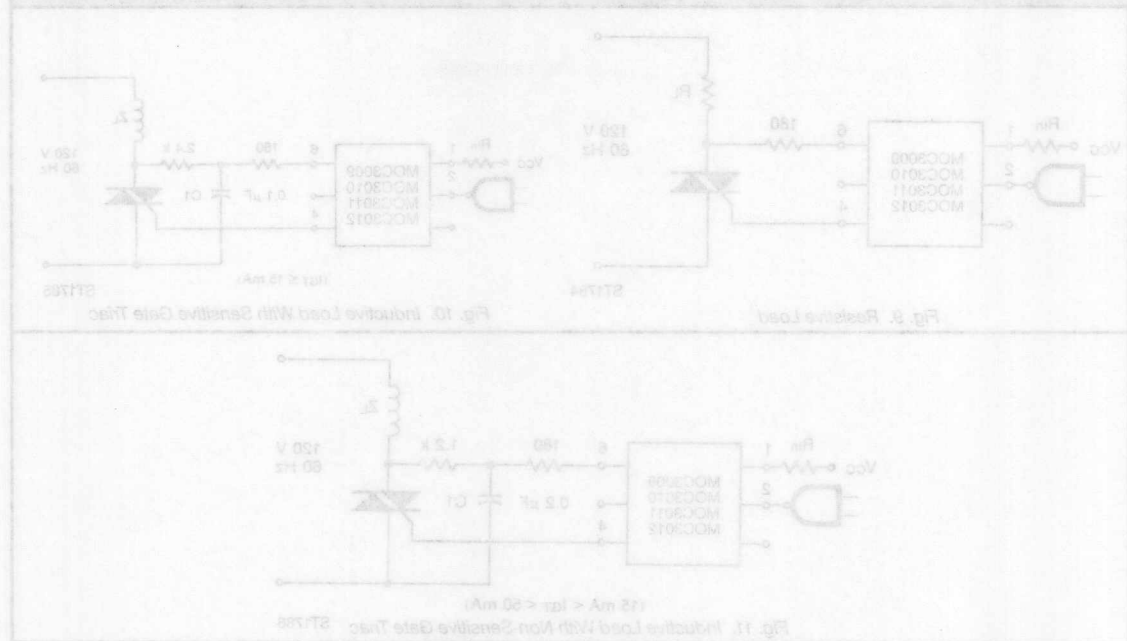


Fig. 11. Inductive Load With Non-Sensitive Gate Triac

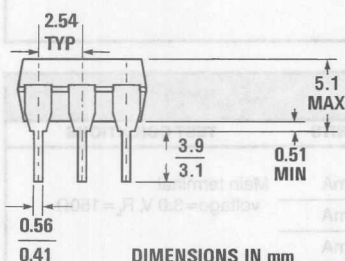
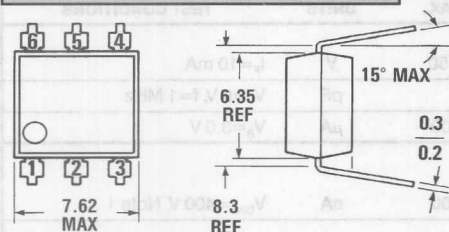
TYPICAL APPLICATION CIRCUITS



**MOC3020 MOC3021
MOC3022 MOC3023**

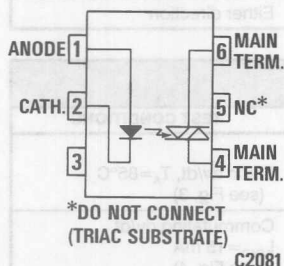
2

PACKAGE DIMENSIONS



DIMENSIONS IN mm
PACKAGE CODE E

ST1603



C2081

Equivalent Circuit

DESCRIPTION

The MOC3020, MOC3021, MOC3022 and MOC3023 are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. This is designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 240 VAC operations.

FEATURES

- Excellent I_T stability—IR emitting diode has low degradation
- High isolation voltage—minimum 7500 VAC peak
- Underwriters Laboratory (UL) recognized—File #E90700

APPLICATIONS

- European applications for 240 VAC
- Triac driver
- Industrial controls
- Traffic lights
- Vending machines
- Motor control
- Solid state relay

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

Storage temperature	−55°C to 150°C
Operating temperature	−40°C to 100°C
Lead temperature (soldering, 10 sec)	260°C

INPUT DIODE

Forward DC current	50 mA
Reverse voltage	3 V
Peak forward current (1 μ s pulse, 300 pps)	3.0 A
Power dissipation (25°C ambient)	100 mW
Derate linearly (above 25°C ambient)	1.33 mW/°C

OUTPUT DRIVER

Off-state output terminal voltage	400 Volts
On-state RMS current (Full cycle, 50 to 60 Hz)	$T_A=25^\circ\text{C}$ 100 mA $T_A=70^\circ\text{C}$ 50 mA
Peak nonrepetitive surge current (PW=10 ms, DC=10%)	1.2 A
Total power dissipation (25°C ambient)	300 mW
Derate above 25°C	4.0 mW/°C

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F		1.2	1.50	V	$I_F=10$ mA
Junction capacitance	C_J		50		pF	$V_F=0$ V, $f=1$ MHz
Reverse leakage current	I_R			100	μ A	$V_R=3.0$ V
OUTPUT DETECTOR						
Peak blocking current, either direction	I_{DRM}	—	10	100	nA	$V_{DRM}=400$ V, Note 1
Peak on-state voltage, either direction	V_{TM}	—	2.5	3.0	Volts	$I_{TM}=100$ mA Peak

Note 1. Test voltage must be applied within dv/dt rating.

TRANSFER CHARACTERISTICS

DC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
LED trigger current (current required to latch output)	MOC3020	I_{FT}	—	30	mA	Main terminal voltage=3.0 V, $R_L=150\Omega$
	MOC3021	I_{FT}	—	15	mA	
	MOC3022	I_{FT}	—	10	mA	
	MOC3023	I_{FT}	—	5	mA	
Holding current	I_H	—	100	—	μ A	Either direction

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
dv/dt RATING						
Critical rate of rise of off-state voltage	dv/dt	—	12	—	V/ μ s	Static dv/dt, $T_A=85^\circ\text{C}$ (see Fig. 3)
Critical rate of rise of commutating voltage	dv/dt	—	0.2	—	V/ μ s	Commutating dv/dt $I_{LOAD}=15$ mA (see Fig. 4)

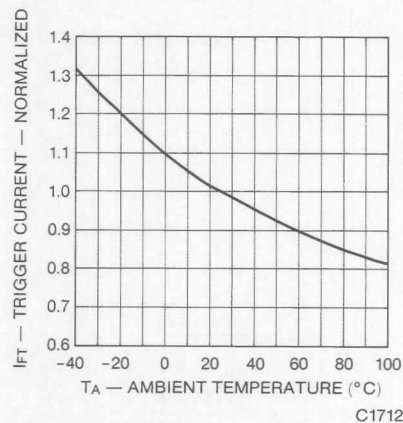
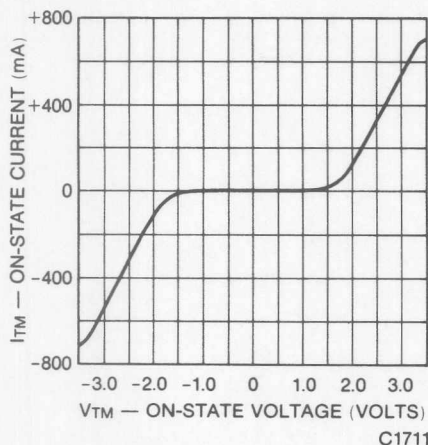
ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage	V_{ISO}	5300			$V_{AC}RMS$	$I_{LO}\leq 1$ μ A, 1 Minute
	V_{ISO}	7500			$V_{AC}PEAK$	$I_{LO}\leq 1$ μ A, 1 Minute
Isolation resistance	R_{ISO}	10^{11}			ohms	$V_{LO}=500$ VDC
Isolation capacitance	C_{ISO}	0.5			pF	$f=1$ MHz

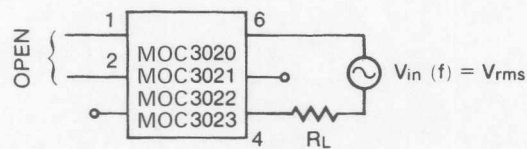
Note 1: Ratings apply to either polarity of pin 6 — referenced to pin 4. Voltages must be applied within dv/dt rating.

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)



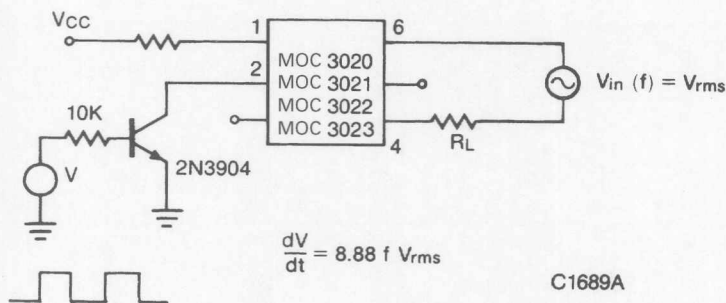
TEST CIRCUITS FOR dV/dt MEASUREMENTS



$$\frac{dV}{dt} = \omega V_{\text{pack}} = 2\pi f \times 1.414 V_{\text{rms}}$$

$$= 8.88 f V_{\text{rms}}$$

Fig. 3. Static dV/dt



$$\frac{dV}{dt} = 8.88 f V_{\text{rms}}$$

C1689A

Fig. 4. Commutating dV/dt

TYPICAL ELECTRICAL CHARACTERISTIC CURVES

(V_{CC} = 5V, I_{TR} = 1mA, unless otherwise specified)

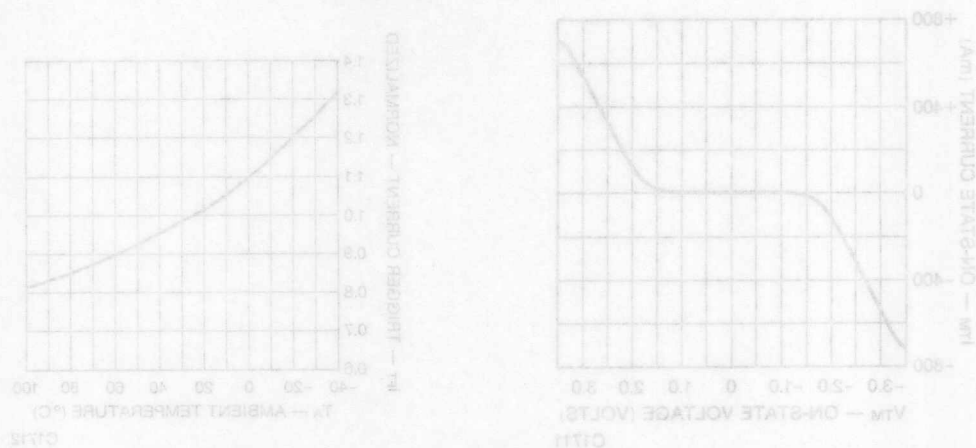


Fig. 2. Trigger Current vs. Temperature

Fig. 1. On-State Characteristics

TEST CIRCUITS FOR DATA MEASUREMENTS

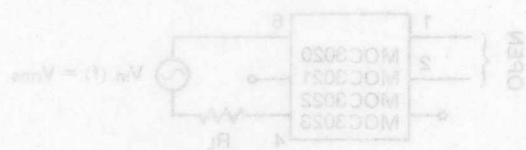


Fig. 3. Static dV/dt

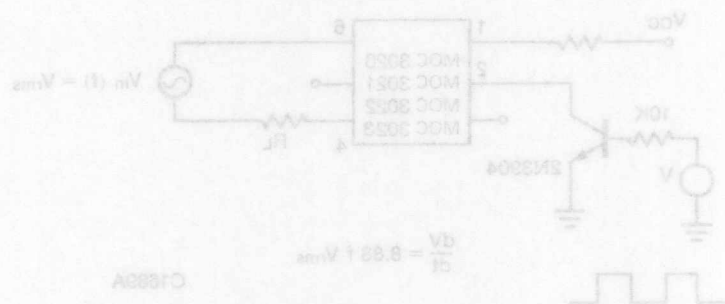


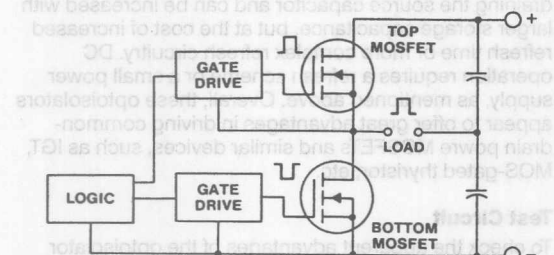
Fig. 4. Constant dV/dt

Common-Drain Power-MOSFET Gate-Drive Solutions Using the H11N/L Optoisolators

by W.H. Sahn

Introduction

Power-MOSFET devices in the half-bridge configuration, Fig. 1, are becoming popular for both switching-power-supplies and PWM (pulse-width-modulated) motor controls. These circuits include a common-drain stage on which the gate and source-terminal potentials, i.e., the control-terminal potentials, rise and fall hundreds of volts in tens of nanoseconds. The magnitude and rate of change of this common-mode voltage places severe constraint on the gate-drive circuitry and represents a challenge to the circuit designer.



ST1664

Fig. 1 - Half-bridge power-MOSFET circuit.

This Note investigates several methods of gate control for these common-drain MOSFET devices. These methods include bootstrap techniques with level shifting accomplished through the use of transistors, optoisolators, and high-voltage ICs. The conclusions are applicable to the power MOSFET, the MOS-IGT, and hybrid MOS-bipolar power switches.

General Considerations

Fast-switching efficient power MOSFETs are widely used for PWM power-control applications. The common-drain-connected n-channel power MOSFET is often utilized in switching-power supplies, motor and solenoid control, and in series-connected high-voltage switches. Although it would appear advantageous to utilize common-source p-channel devices in these sockets to simplify gate-drive circuitry, the penalty caused by the use of p-channel devices is too severe in all but the lower-circuit lower-voltage application areas. This situation will remain until III-V enhancement-mode devices become widely available at low cost (if they ever prove viable), because silicon p-channel devices will always require much more silicon area to provide the same ratings. This large die area imposes an economic penalty in device cost, a performance penalty in the increased capacitance associated with the larger die area, and the complete lack of device availability in the higher current and/or voltage ratings. These facts assure a long life for the common-drain power-MOSFET configuration. Note also

that a good MOSFET gate-drive design could allow replacement of a preamp bipolar with a MOSFET in the drive of a bipolar common-collector high-power output, which could almost eliminate the need for a floating current source.

The complexity of driving the gate of this common-drain power MOSFET derives from two fundamental facts: the lack of a fixed reference point for the gate signal and the need for a gate voltage with a value higher than the positive supply rail being controlled. Although these factors are also present in bipolar-transistor common-collector stages, the fast switching and the magnitude of the gate signal in power-MOS devices places more stringent requirements on the circuit design. To minimize power dissipation in the conducting state, the gate-source voltage should be greater than 10V but less than 20V, assuring minimum on-state resistance without danger of damage to the fragile gate oxide. To minimize power dissipation during switching, the gate voltage should have fast rise and fall times when driving the highly capacitive gate. Although this explanation is simple and elementary, it is not trivial when examined from a practical viewpoint. Mass-produced circuits are constrained to be very compatible with automated assembly, to be very consistent in performance over the tolerance limits of the standard components used, to perform reliably in an application for long time periods and, if failure occurs, to fail in a manner that will not create a safety hazard.

This combination of performance, manufacturability, reliability, and safety impact the design of the gate-drive circuit, which must meet cost and design-schedule goals. The performance issues that will determine the gate-drive circuit configuration include adequate speed and drive capability, total system-power dissipation, and common-mode transient immunity. The manufacturability issues include standard components, tolerance sensitivity, automatic assembly, size, adaptability, cost, and quantity used. Reliability and safety are impacted by power dissipation, parts count, isolation, noise-transient overvoltage susceptibility, ease and speed of shutdown, fault-sensing compatibility, and failure consequences. Although this is not an all-inclusive list, it serves as a starting point to evaluate a gate-drive configuration for a common-drain power MOS.

The simplest gate-drive circuit directly transfer energy to the gate from the control-circuitry low-voltage supply at logic ground. Although photovoltaic and piezoelectric elements are sometimes used, they provide too little output current to be compatible with fast charging and discharging of the MOSFET gate capacitance. Pulse transformers can supply large currents, although they

can be difficult to obtain with risetime capability compatible with the power MOSFET. Other possible difficulties with pulse transformers include input-to-output capacitance, automatic-insertion compatibility, and the feedback of signals from the power stages to the control circuitry. Specialty transformers can be designed to overcome these disadvantages, although economic viability may suffer. Dielectric isolation in these energy-transfer devices eliminates the possibility of high-voltage power being present on the low-voltage control circuits in a fault condition.

The most common gate-drive circuits utilize a source of stored energy referenced to the source of the common-drain stage. Although this source can be a floating power supply powered through a transformer, or piezoelectric or photovoltaic element, it will usually be a capacitor that is charged directly from either the low-voltage control supply (flying capacitor) or the positive power rail (bootstrap) during periods when the common-drain stage is blocking. The bootstrap circuit capacitor may be recharged during long conduction periods of the common-drain MOSFET by using load current. Channel resistance is momentarily allowed to rise until drain-source voltage reaches the approximately 15V required to recharge. To provide this recharge or "refresh" of a flying-capacitor circuit, the common-drain stage must fully turn off and block full supply voltage. The charge on this capacitor is a supply for the gate of the common-drain power MOSFET and its control circuitry. The control circuitry can be as simple as a resistor and high-voltage level-shift transistor, but usually consists of several devices to provide gain, fast switching, noise suppression, voltage stability, and other desired functions. Simple optoisolators are often used to provide the control-signal path from the low-voltage circuitry, although speed can be marginal in many cases. Until recently the more complex optoisolators would provide speed, but were limited in common-mode rejection and in voltage capability. The high-voltage integrated circuit (HVIC) has also become available recently, providing both the level shift of the control signal and the signal processing for the common-drain MOSFET gate drive. It also can be designed to provide over-current protection, automatic refresh, and coordination of conduction times of the common-drain and common-source stages. Devices available to date can operate up to 500V and above 20 kHz. These HVICs are normally designed as application-specific devices for specific system applications.

Optoisolator Characteristics

Recently, high-speed optoisolators, with excellent common-mode rejection and wide supply-voltage compatibility, have become available. The simplest and least costly of these devices are six-pin dual-in-line plastic-packaged infrared diode-input Schmitt-trigger-output configurations. Two basic derivations are commonly available, one being optimized for fast switching and one for low power consumption. These derivations are convenient for the power-MOSFET-circuit designer, as a basic "universal" circuit can be designed, and only the optoisolator changed for a choice of either longer duty cycles (>10 ms) at moderate speeds (≤ 200 kHz @ 150 ns t_r , t_f), or a shorter duty cycle operating to more than 2 MHz with 15-ns transitions. Duty cycles are limited by the Schmitt-trigger power-supply current draining the source capacitor and can be increased with larger storage capacitance, but at the cost of increased refresh time or more complex refresh circuitry. DC operation requires a refresh scheme or a small power supply, as mentioned above. Overall, these optoisolators appear to offer great advantages in driving common-drain power MOSFETs and similar devices, such as IGT, MOS-gated thyristor, etc.

Test Circuit

To check the apparent advantages of the optoisolator approach, a circuit was built that employed the H11L (slow) and H11N (fast) optoisolated Schmitt triggers. A plug-in prototype board was used to construct the circuit of Fig. 2. The circuit makes use of an IRF630 power-MOSFET switch and replaces the lower FET with a 45-ohm power-resistor source load. A 1- μ F aluminum electrolytic capacitor was used as the bootstrap supply, with a variable dc power source for V_{BB} supply was kept below 75V to keep the circuit within the IRF630 ratings during the turn-off spike. No heatsinks or special wiring precautions were used. Although only the H11N1 is actually specified for common-mode rejection at 2000 V/ μ s minimum, the lower-cost H11L1 uses similar shielding in the IC chip, and identical packaging. These similar features of the H11L1 and N1 lead to the expectation of a similar ability to function under high dv/dt.

Tests of the circuit confirmed the expected performance for both optoisolators in the circuit. The H11L was driven from 5V pulses with a 2K resistor, and drives the IRF630 at about 300 kHz with a 12% duty cycle. Turn-on and

turn-off times of the IRF630 were about 60 ns, which yielded more than 2000-V/ μ s dv/dt during the 175V turn-off spike. These waveforms are illustrated in Fig. 3. The H11N1 was then substituted for the H11L, and the value of the infrared diode-limiting resistor was reduced to 680 ohms. Operation at 1 MHz

was confirmed. Higher-frequency operation was obtainable through heatsinking of the IRF630 and the use of a higher-rated load resistor. The waveform presented in Fig. 4 illustrates this operation, and about the same dv/dt as the H11L provided.

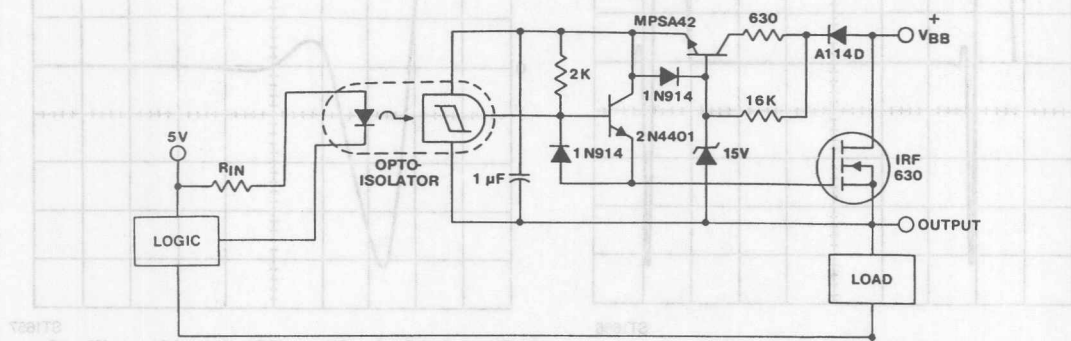


Fig. 2 - Optically isolated power-MOSFET-driver test circuit.

ST1655

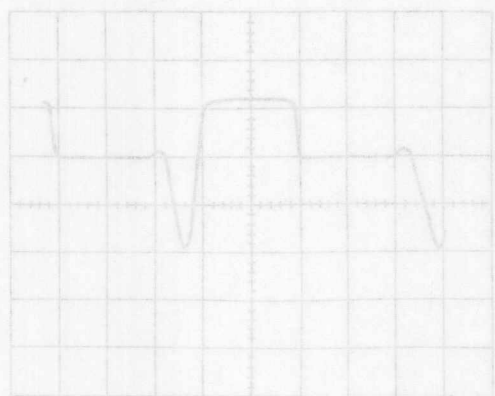


Fig. 3 Waveforms taken with an H11L in the test circuit.

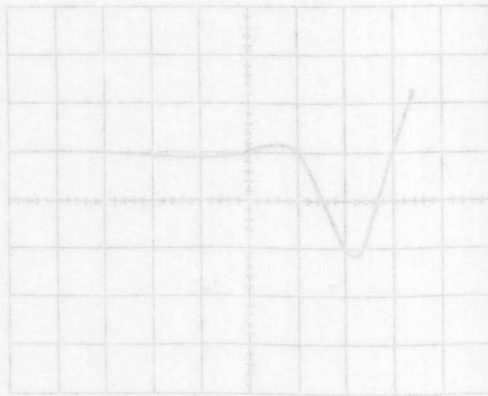
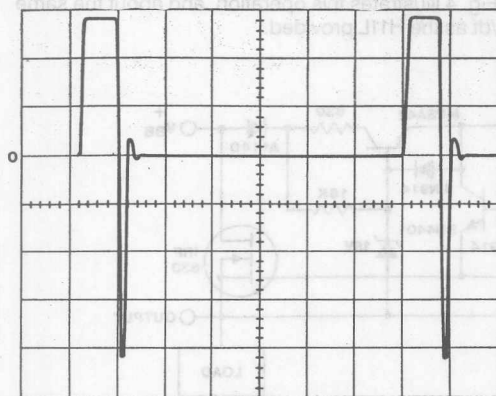


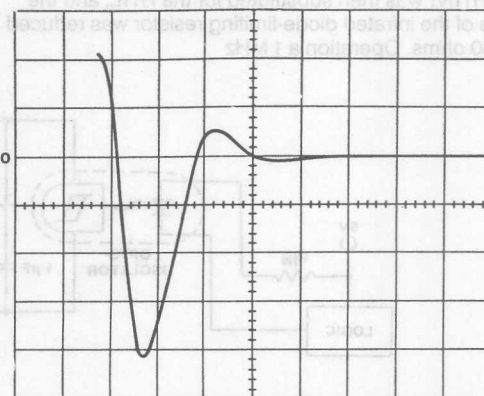
Fig. 4 Waveforms taken with an H11N1 in the test circuit.



ST1656

a) Load Voltage Across 45Ω
V=20 V/Division
t=500 ns/Division

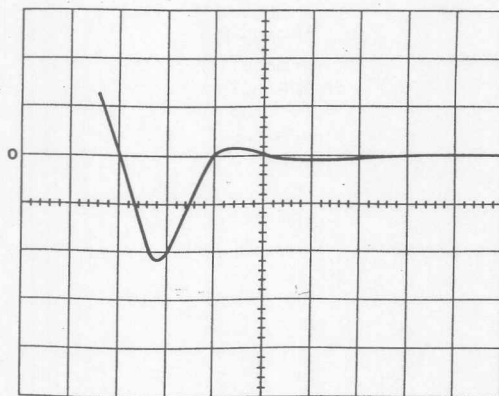
Fig. 1.



ST1657

b) Expanded Scale of Turnoff Portion of Above Waveform
V=20 V/Division
t=50 ns/Division

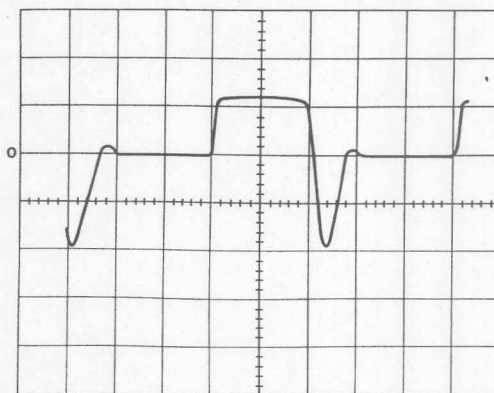
Fig. 2.



ST1658

c) Turnoff Waveforms with V_{BS} to Increase Load Voltage to 75V
V=50 V/Division
t=50 ns/Division

Fig. 3 Waveforms taken with an H11L in the test circuit.



ST1659

V=50 V/Division
t=200 ns/Division

Fig. 4 Waveforms Taken With An H11N In The Test Circuit

INFRARED COMPONENTS AND ASSEMBLIES

Alphanumeric Product Listing

3

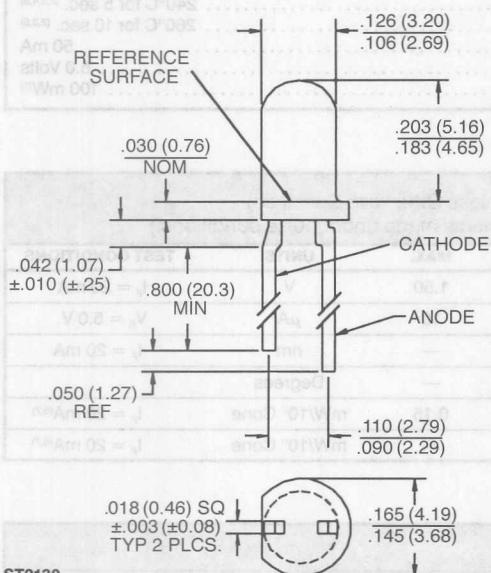
Product	Page	Product	Page	Product	Page
1N6264	3-127	H22A2	3-225	OPB703	3-95
1N6265	3-131	H22A3	3-225	OPB703W	3-97
1N6266	3-135	H22A4	3-229	OPB704	3-95
BPW36	3-193	H22A5	3-229	OPB704W	3-97
BPW37	3-193	H22A6	3-229	OPB705	3-95
BPW38	3-197	H22B1	3-233	OPB705W	3-97
CNY28	3-263	H22B2	3-233	OPB706A	3-99
CNY29	3-267	H22B3	3-233	OPB706B	3-99
CNY36	3-271	H22B4	3-237	OPB706C	3-99
CQX14	3-201	H22B5	3-237	OPB804	3-101
CQX15	3-205	H22B6	3-237	OPB860N11	3-103
CQX16	3-201	H22L1	3-245	OPB860N51	3-103
CQX17	3-205	H22L2	3-245	OPB860N55	3-103
F5D1	3-141	H23A1	3-249	OPB860T11	3-115
F5D2	3-141	H23A2	3-249	OPB860T51	3-115
F5D3	3-141	H23B1	3-253	OPB860T55	3-115
F5E1	3-145	H23L1	3-257	OPB861N51	3-105
F5E2	3-145	L14C1	3-165	OPB861N55	3-105
F5E3	3-145	L14C2	3-165	OPB861T51	3-117
F5F1	3-149	L14F1	3-169	OPB861T55	3-117
F5G1	3-153	L14F2	3-169	OPB862N51	3-107
H21A1	3-209	L14G1	3-173	OPB862N55	3-107
H21A2	3-209	L14G2	3-173	OPB862T51	3-119
H21A3	3-209	L14G3	3-173	OPB862T55	3-119
H21A4	3-213	L14N1	3-177	OPB865N11	3-109
H21A5	3-213	L14N2	3-177	OPB865N51	3-109
H21A6	3-213	L14P1	3-181	OPB865N55	3-109
H21B1	3-217	L14P2	3-181	OPB865T11	3-121
H21B2	3-217	L14Q1	3-185	OPB865T51	3-121
H21B3	3-217	L14R1	3-189	OPB865T55	3-121
H21B4	3-221	LED55B	3-157	OPB866N51	3-111
H21B5	3-221	LED55BF	3-161	OPB866N55	3-111
H21B6	3-221	LED55C	3-157	OPB866T51	3-123
H21L1	3-241	LED55CF	3-161	OPB866T55	3-123
H21L2	3-241	LED56	3-157	OPB867N51	3-113
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INFRARED COMPONENTS AND ASSEMBLIES

Alphanumeric Product Listing

Product	Page	Product	Page	Product	Page
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QEC112	3-3	QSA158	3-21	QVA11323	3-81
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QEC121	3-5	QSC112	3-25	QVA11333	3-81
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QED221	3-9	QSD123	3-29	QVA21214	3-81
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QED233	3-11	QSD128	3-31	QVA21314	3-81
QED234	3-11	QSD422	3-33	QVB11123	3-85
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QED423	3-13	QSD424	3-33	QVB11133	3-85
QED522	3-15	QSD722	3-35	QVB11134	3-85
QED523	3-15	QSD723	3-35	QVB11223	3-85
QEE113	3-17	QSD724	3-35	QVB11224	3-85
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QEE123	3-19	QSE113	3-39	QVB11234	3-85
QPA1223	3-53	QSE114	3-39	QVB11323	3-85
QPA8259	3-55	QSE122	3-41	QVB11324	3-85
QPC1213	3-57	QSE123	3-41	QVB11333	3-85
QPD1223	3-59	QSE133	3-43	QVB11334	3-85
QPD5223	3-61	QSE156	3-45	QVB21113	3-85
QPE1113	3-63	QSE157	3-45	QVB21114	3-85
QPE1259	3-65	QSE158	3-45	QVB21213	3-85
QRB1113	3-69	QSE159	3-45	QVB21214	3-85
QRB1114	3-69	QSE773	3-49	QVB21313	3-85
QRB1133	3-71	QSE973	3-51	QVB21314	3-85
QRB1134	3-71	QVA11123	3-81	QVE11233	3-89
QRC1113	3-73	QVA11124	3-81	QVL21653	3-91
QRC1133	3-75	QVA11133	3-81	QVL25335	3-93
QRD1113	3-77	QVA11134	3-81		

PACKAGE DIMENSIONS



ST2130

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS ±.010 (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES CATHODE.

DESCRIPTION

The QEC11X is a 940 nm GaAs LED encapsulated in a clear, peach tinted, plastic T-1 package.

FEATURES

- Tight production E_{θ} distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow emission angle.
- Mechanically and wavelength matched to QSC11X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

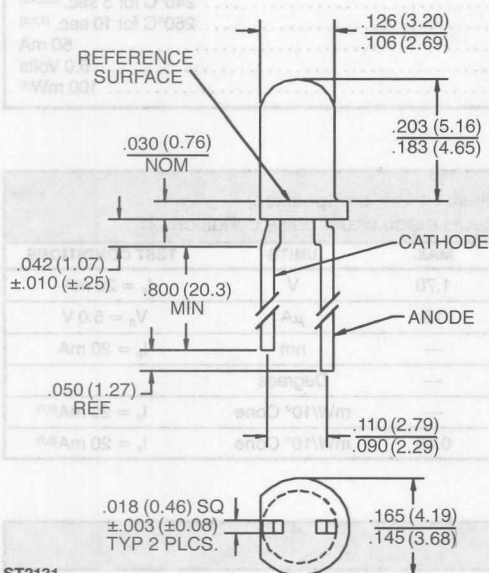
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.50	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 5.0 \text{ V}$
Peak Emission Wavelength	λ_P	—	940	—	nm	$I_F = 20 \text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ	—	± 8	—	Degrees	
Radiant Incidence QSC112	E_θ	0.03	—	0.15	mW/10° Cone	$I_F = 20 \text{ mA}^{(6,7)}$
Radiant Incidence QSC113	E_θ	0.07	—	—	mW/10° Cone	$I_F = 20 \text{ mA}^{(6,7)}$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Measurement is taken at the end of a single 100 μsec pulse.
7. E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

PACKAGE DIMENSIONS



ST2131

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS ±.010 (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES CATHODE.

DESCRIPTION

The QEC12X is an 880 nm AlGaAs LED encapsulated in a clear, purple tinted, plastic T-1 package.

FEATURES

- Tight production E_s distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow emission angle.
- Mechanically and wavelength matched to QSC11X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

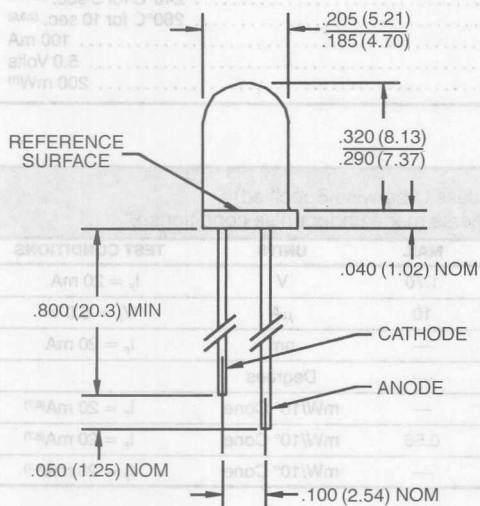
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 5.0\text{ V}$
Peak Emission Wavelength	λ_P	—	880	—	nm	$I_F = 20\text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ	—	± 8	—	Degrees	
Radiant Incidence QEC121	E_θ	0.07	—	—	mW/10° Cone	$I_F = 20\text{ mA}$ ^(6,7)
Radiant Incidence QEC122	E_θ	0.13	—	0.45	mW/10° Cone	$I_F = 20\text{ mA}$ ^(6,7)

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Measurement is taken at the end of a single 100 μsec pulse.
7. E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

QED121/122/123

PACKAGE DIMENSIONS

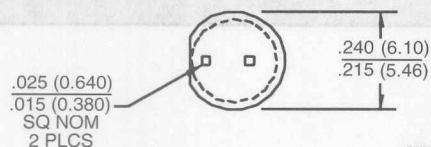


DESCRIPTION

The QED12X is an 880 AlGaAs LED encapsulated in a clear, peach tinted, plastic T-1 $\frac{1}{4}$ package.

FEATURES

- Tight production E_g distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Very narrow emission angle.
- Mechanically and wavelength matched to QSD12X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.



ST2132

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES CATHODE.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. (2,3,5)
Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

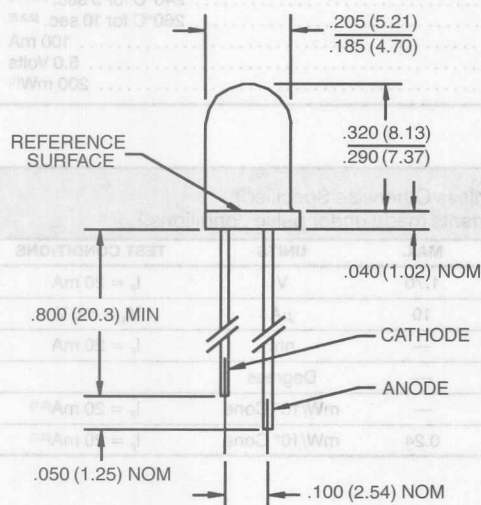
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 5.0 \text{ V}$
Peak Emission Wavelength	λ_p	—	880	—	nm	$I_F = 20 \text{ mA}$
Emission Angle at ½ Power	θ	—	± 9	—	Degrees	
Radiant Incidence QED121	E_θ	0.08	—	—	mW/10° Cone	$I_F = 20 \text{ mA}^{(6,7)}$
Radiant Incidence QED122	E_θ	0.16	—	0.56	mW/10° Cone	$I_F = 20 \text{ mA}^{(6,7)}$
Radiant Incidence QED123	E_θ	0.24	—	—	mW/10° Cone	$I_F = 20 \text{ mA}^{(6,7)}$

NOTES

- Derate power dissipation linearly 2.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip 1/16" (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Measurement is taken at the end of a single 100 μsec pulse.
- E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

QED221/222

PACKAGE DIMENSIONS

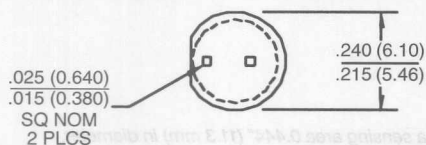


DESCRIPTION

The QED22X is an 880nm AlGaAs LED encapsulated in a clear, purple tinted, plastic T-1 $\frac{1}{4}$ package.

FEATURES

- Tight production E_g distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Wide emission angle.
- Mechanical and wavelength matched to QSD12X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.



ST2133

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES CATHODE.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

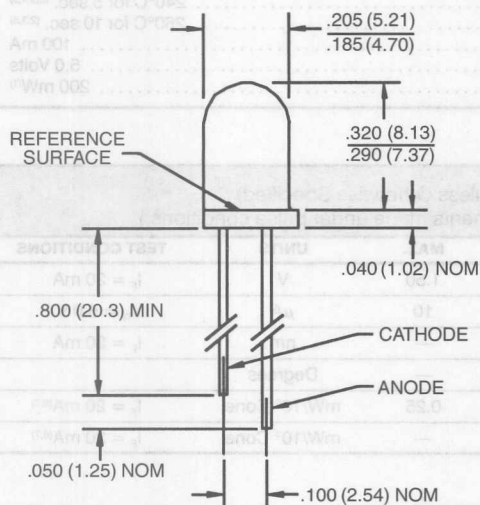
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 5.0\text{ V}$
Peak Emission Wavelength	λ_P	—	880	—	nm	$I_F = 20\text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ	—	± 20	—	Degrees	
Radiant Incidence QED221	E_θ	0.065	—	—	mW/10° Cone	$I_F = 20\text{ mA}$ ^(6,7)
Radiant Incidence QED222	E_θ	0.085	—	0.24	mW/10° Cone	$I_F = 20\text{ mA}$ ^(6,7)

NOTES

1. Derate power dissipation linearly $2.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Measurement is taken at the end of a single $100\text{ }\mu\text{sec}$ pulse.
7. E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444 " (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54 " (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

QED233/234

PACKAGE DIMENSIONS

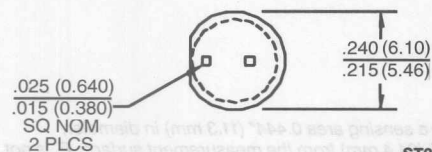


DESCRIPTION

The QED23X is a 940nm GaAs LED encapsulated in a clear plastic T-1 $\frac{1}{4}$ package.

FEATURES

- Tight production E_g distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Wide emission angle.
- Mechanical and wavelength matched to QSD12X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- Medium and high irradiance level.



NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES CATHODE.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

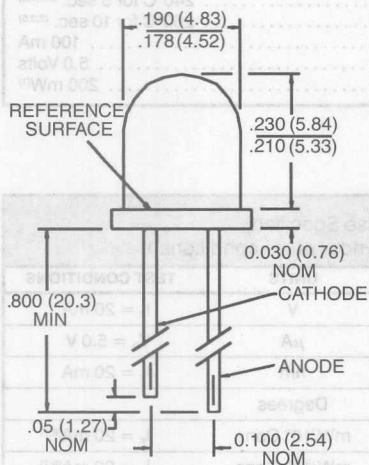
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.50	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 5.0 \text{ V}$
Peak Emission Wavelength	λ_P	—	940	—	nm	$I_F = 20 \text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ	—	± 20	—	Degrees	
Radiant Incidence QED233	E_θ	0.05		0.25	mW/10° Cone	$I_F = 20 \text{ mA}$ ^(6,7)
Radiant Incidence QED234	E_θ	0.13		—	mW/10° Cone	$I_F = 20 \text{ mA}$ ^(6,7)

NOTES

- Derate power dissipation linearly 2.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Measurement is taken at the end of a single 100 μsec pulse.
- E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

PACKAGE DIMENSIONS

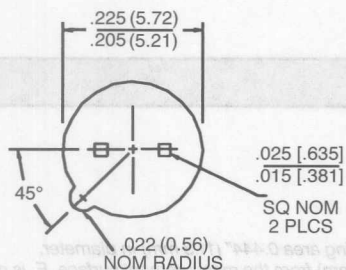


DESCRIPTION

The QED42X is an 880nm AlGaAs LED encapsulated in a clear, purple tinted, plastic TO-46 package.

FEATURES

- Tight production E_g distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Wide emission angle.
- Mechanical and wavelength matched to QSD42X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.



ST2135

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. TAB DENOTES CATHODE.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

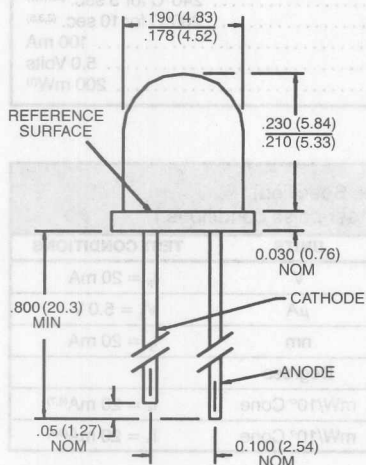
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 5.0 \text{ V}$
Peak Emission Wavelength	λ_P	—	880	—	nm	$I_F = 20 \text{ mA}$
Emission Angle at ½ Power	θ	—	± 35	—	Degrees	
Radiant Incidence QED422	E_θ	0.05		0.25	mW/10° Cone	$I_F = 20 \text{ mA}$ ^(6,7)
Radiant Incidence QED234	E_θ	0.10		—	mW/10° Cone	$I_F = 20 \text{ mA}$ ^(6,7)

NOTES

- Derate power dissipation linearly 2.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip 1/16" (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Measurement is taken at the end of a single 100 μsec pulse.
- E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

PACKAGE DIMENSIONS

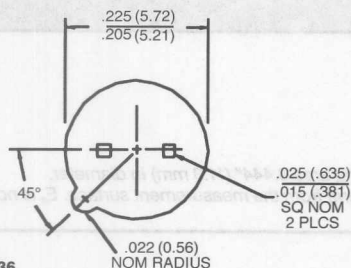


DESCRIPTION

The QED52X is an 880 nm AlGaAs LED encapsulated in a clear, peach tinted, plastic TO-46 package.

FEATURES

- Tight production E_s distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow emission angle.
- Mechanically and wavelength matched to QSD72X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.



ST2136

NOTES:

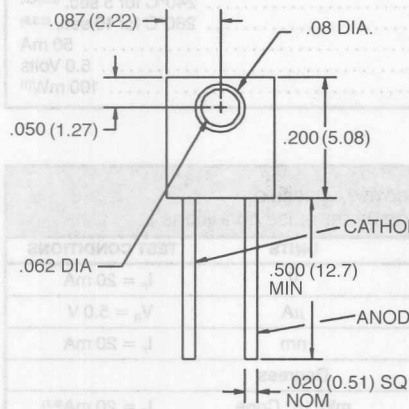
1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. TAB DENOTES CATHODE.

ABSOLUTE MAXIMUM RATINGS (T _A = 25°C Unless Otherwise Specified)	
Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. (2,3,5)
Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS (T _A = 25°C Unless Otherwise Specified) (All measurements made under pulse conditions.)						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V _F	—	—	1.70	V	I _F = 20 mA
Reverse Leakage Current	I _R	—	—	10	μA	V _R = 5.0 V
Peak Emission Wavelength	λ _p	—	880	—	nm	I _F = 20 mA
Emission Angle at ½ Power	θ	—	± 15	—	Degrees	
Radiant Incidence QED522	E _θ	0.10	—	0.45	mW/10° Cone	I _F = 20 mA ^(6,7)
Radiant Incidence QED523	E _θ	0.20	—	—	mW/10° Cone	I _F = 20 mA ^(6,7)

NOTES	
- Derate power dissipation linearly 2.67 mW/°C above 25°C. - RMA flux is recommended. - Methanol or Isopropyl alcohols are recommended as cleaning agents. - Soldering iron tip 1/16" (1.6 mm) minimum from housing. - As long as leads are not under any stress or spring tension. - Measurement is taken at the end of a single 100 μsec pulse. - E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.	

PACKAGE DIMENSIONS

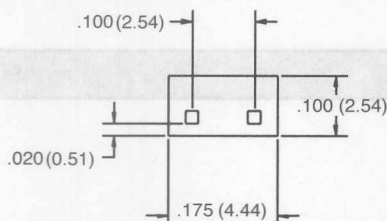


DESCRIPTION

The QEE113 is a 940 nm GaAs LED encapsulated in a wide angle, orange, plastic sidelooker shell package.

FEATURES

- Tight production E_b distribution with min/max limits.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Mechanically and wavelength matched to QSE11X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.



ST2128

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

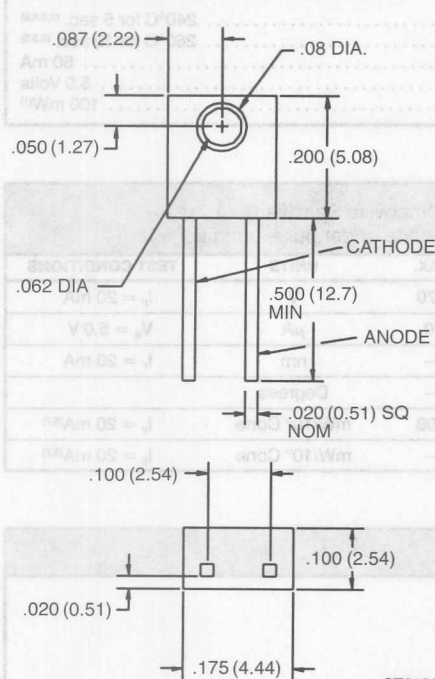
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.50	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 5.0 \text{ V}$
Peak Emission Wavelength	λ_P	—	940	—	nm	$I_F = 20 \text{ mA}$
Emission Angle at ½ Power	θ	—	± 25	—	Degrees	
Radiant Incidence	E_θ	0.015			mW/10° Cone	$I_F = 20 \text{ mA}$ ^(6,7)

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Measurement is taken at the end of a single 100 μsec pulse.
7. E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

PACKAGE DIMENSIONS



NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QEE12X is an 880 nm AlGaAs LED encapsulated in a wide angle, dark green, plastic sidelooker shell package.

FEATURES

- Tight production E_g distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Mechanically and wavelength matched to QSE11X series phototransistor.
- Plastic package color allows easy recognition from phototransistor.
- High irradiance level.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

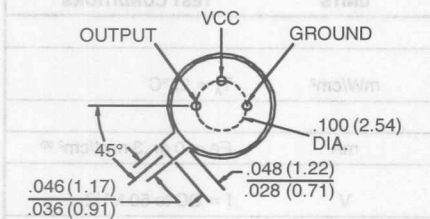
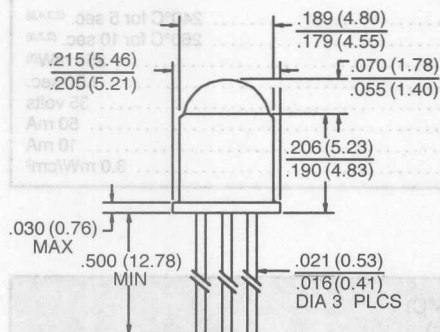
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 5.0\text{ V}$
Peak Emission Wavelength	λ_P	—	880	—	nm	$I_F = 20\text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ	—	± 25	—	Degrees	
Radiant Incidence QEE122	E_θ	0.02	—	0.08	mW/10° Cone	$I_F = 20\text{ mA}$ ^(6,7)
Radiant Incidence QEE123	E_θ	0.04	—	—	mW/10° Cone	$I_F = 20\text{ mA}$ ^(6,7)

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Measurement is taken at the end of a single 100 μsec pulse.
7. E_θ is a measurement of the average apertured radiant energy incident upon a sensing area 0.444" (11.3 mm) in diameter, perpendicular to and centered on the mechanical axis of the lens, and 2.54" (64.4 mm) from the measurement surface. E_θ is not necessarily uniform within the measurement area.

QSA156/157/158/159

PACKAGE DIMENSIONS



ST2139

DESCRIPTION

The QSA15X family are OPTOLOGIC™ ICs which feature a Schmitt trigger at output which provides hysteresis for noise immunity and pulse shaping. The basic building block of this IC consists of a photodiode, a linear amplifier, voltage regulator, Schmitt trigger and four output options. The TTL/LSTTL compatible output can drive up to ten TTL loads over supply currents from 4.5 to 16.0 volts. The monolithic die is packaged in a narrow angle, hermetically sealed, TO-18 metal can package.

FEATURES

- High noise immunity.
- Direct TTL/LSTTL interface.
- Hermetically sealed package.
- Reception angle of $\pm 12^\circ$.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Operating Supply Voltage	V_{CC}	$V_{CC} - 2.5$		16.0	V	
Positive Going Threshold	V_{TH}			0.250	V	
Hysteresis Ratio	V_{TH}/V_{TL}	1.0		2.00		
Supply Current	I_{CC}			15.0	mA	
Peak to peak ripple which will cause false triggering	V_{PP}			2.00	V	
QSA156 (BUFFER TOTEM POLE)						
High Level Output Voltage	V_{OH}	$V_{CC} - 2.5$		—	V	$E_o = 3 \text{ mW/cm}^2$ $I_{OL} = -1.0 \text{ mA}$
Low Level Output Voltage	V_{OL}			0.40	V	$E_o = 0$, $I_{OL} = 16 \text{ mA}$
QSA157 (INVERTER TOTEM POLE)						
High Level Output Voltage	V_{OH}	$V_{CC} - 2.5$		—	V	$E_o = 0$, $I_{OH} = -1.0 \text{ mA}$
Low Level Output Voltage	V_{OL}			0.40	V	$E_o = 3 \text{ mW/cm}^2$ $I_{OL} = 16 \text{ mA}$
QSA158 (BUFFER OPEN COLLECTOR)						
High Level Output Current	I_{OH}			100	μA	$E_o = 3 \text{ mW/cm}^2$ $V_{OL} = 30 \text{ V}$
Low Level Output Voltage	V_{OL}			0.40	V	$E_o = 0$, $I_{OL} = 16 \text{ mA}$
QSA159 (INVERTER OPEN COLLECTOR)						
High Level Output Current	I_{OH}			100	μA	$E_o = 0$, $V_{OL} = 30 \text{ V}$
Low Level Output Voltage	V_{OL}			0.40	V	$E_o = 3 \text{ mW/cm}^2$ $I_{OL} = 16 \text{ mA}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Supply Voltage, V_{CC}	18 volts
Storage Temperature	-65°C to $+125^\circ\text{C}$
Operating Temperature	-55°C to $+105^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Power Dissipation	250 mW ⁽¹⁾
Duration of Output short to V_{CC}	1.00 sec.
Voltage at Output	35 volts
Sinking Current	50 mA
Sourcing Current (QSA156, QSA157)	10 mA
Irradiance	3.0 mW/cm^2

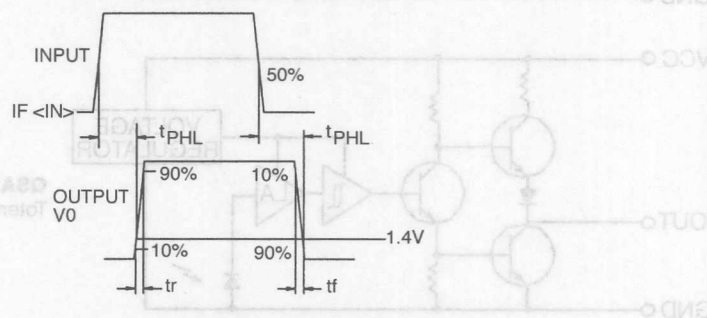
ELECTRICAL CHARACTERISTICS ($T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)
($V_{CC} = 4.5$ to 16 volts)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Operating Supply Voltage	V_{CC}	4.5		16.0	V	
Positive Going Threshold Irradiance ⁽⁶⁾	$E_e (+)$	0.025		0.250	mW/cm^2	$T_A = 25^\circ\text{C}$
Hysteresis Ratio	$E_e(+)/E_e(-)$	1.10		2.00		
Supply Current	I_{CC}	—		12.0	mA	$E_e = 0$ or $.3 \text{ mW/cm}^2$ ⁽⁶⁾
Peak to peak ripple which will cause false triggering		—		2.00	V	$f = \text{DC to } 50 \text{ MHz}$
QSA156 (BUFFER TOTEM POLE)						
High Level Output Voltage	V_{OH}	$V_{CC} - 2.1$		—	V	$E_e = .3 \text{ mW/cm}^2$, $I_{OH} = -1.0 \text{ mA}$ ⁽⁶⁾
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = 0$, $I_{OL} = 16 \text{ mA}$
QSA157 (INVERTER TOTEM POLE)						
High Level Output Voltage	V_{OH}	$V_{CC} - 2.1$		—	V	$E_e = 0$, $I_{OH} = -1.0 \text{ mA}$
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = .3 \text{ mW/cm}^2$, $I_{OL} = 16 \text{ mA}$ ⁽⁶⁾
QSA158 (BUFFER OPEN COLLECTOR)						
High Level Output Current	I_{OH}	—		100	μA	$E_e = .3 \text{ mW/cm}^2$, $V_{OH} = 30 \text{ V}$ ⁽⁶⁾
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = 0$, $I_{OL} = 16 \text{ mA}$
QSA159 (INVERTER OPEN COLLECTOR)						
High Level Output Current	I_{OH}	—		100	μA	$E_e = 0$, $V_{OH} = 30 \text{ V}$
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = .3 \text{ mW/cm}^2$, $I_{OL} = 16 \text{ mA}$ ⁽⁶⁾

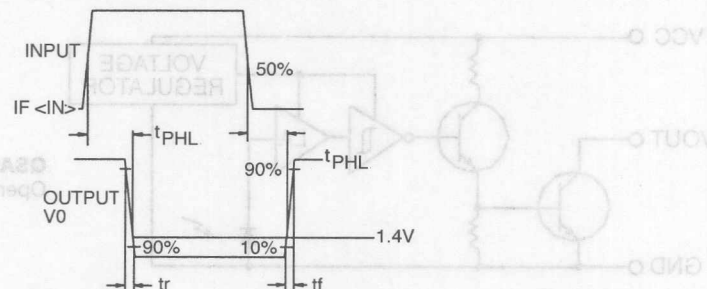
ELECTRICAL CHARACTERISTICS ($T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)
($V_{CC} = 4.5$ to 16 volts)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
QSA156, QSA157						
Output rise, fall times	t_r, t_f	—		70	nS	$E_e = 0$ or $.3 \text{ mW/cm}^2$, $f = 10 \text{ KHZ}$
Propagation delay	t_{PHL}, t_{PLH}		6.0		μS	$\text{DC} = 50\%$, $R_L = 10 \text{ TTL loads}$
QSA158, QSA159						
Output rise, fall times	t_r, t_f	—		100	nS	$E_e = 0$ or $.3 \text{ mW/cm}^2$, $f = 10 \text{ KHZ}$
Propagation delay	t_{PHL}, t_{PLH}		6.0		μS	$\text{DC} = 50\%$, $R_L = 300\Omega^{(6)}$

Switching Test Curve For Buffers



Switching Test Curve For Inverters

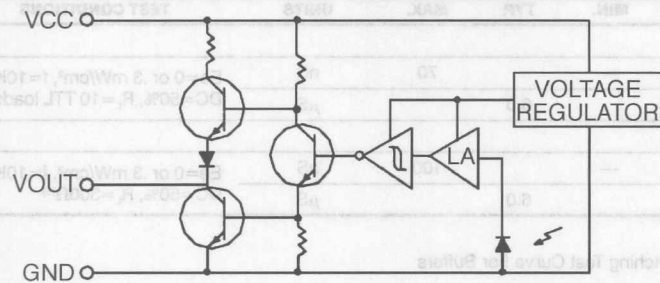


ST2141

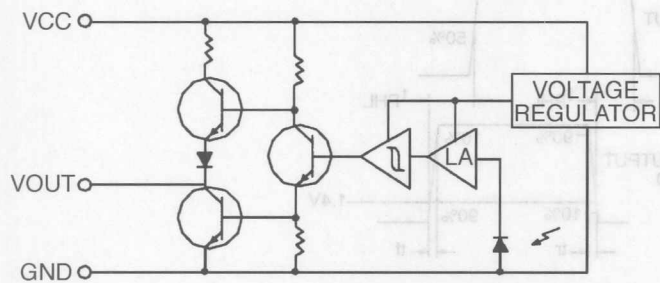
NOTES

1. Derate power dissipation linearly $2.50 \text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Irradiance measurements are made with an AlGaAs LED emitting light at a peak wavelength of 880 nm .

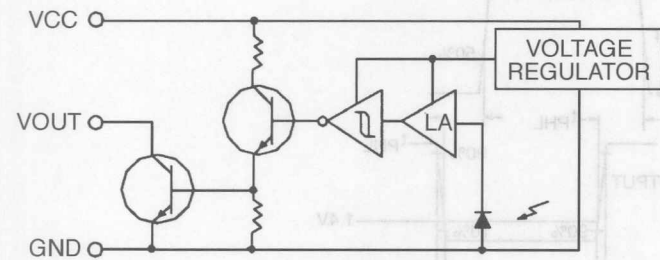
CIRCUIT SCHEMATICS



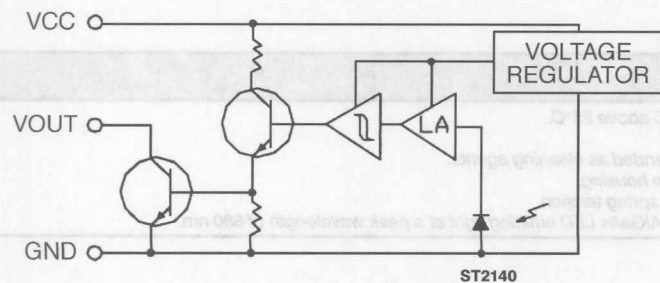
QSA156
Totem-Pole Output Buffer



QSA157
Totem-Pole Output Inverter



QSA158
Open-Collector Output Buffer

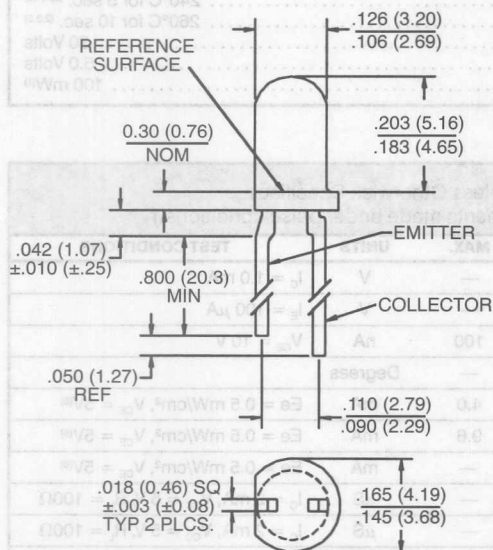


QSA159
Open-Collector Output Inverter

ST2140

QSC112/113/114

PACKAGE DIMENSIONS



ST2142

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS ±.010 (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES CATHODE.

DESCRIPTION

The QSC11X is a silicon phototransistor encapsulated in an infrared transparent, black T-1 package.

FEATURES

- Tight production distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Plastic package is infrared transparent black to attenuate visible light.
- Mechanically and spectrally matched to the QECXXX LED.
- Black plastic body allows easy recognition from LED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

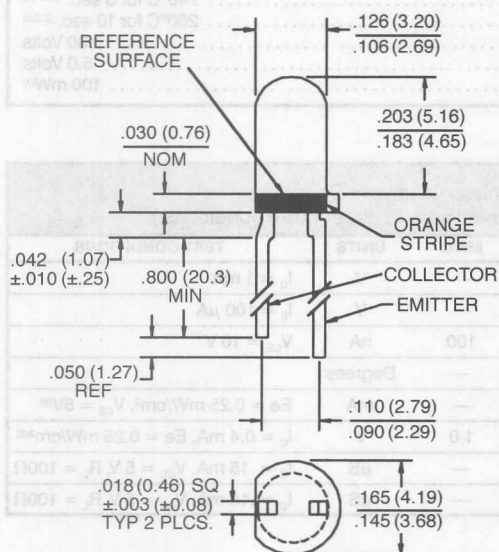
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0 \text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100 \mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10 \text{ V}$
Reception Angle at ½ Sensitivity	θ	—	± 8	—	Degrees	
On-State Collector Current QSC112	$I_{C(ON)}$	1.0	—	4.0	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
On-State Collector Current QSC113	$I_{C(ON)}$	2.4	—	9.6	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
On-State Collector Current QSC114	$I_{C(ON)}$	4.0	—	—	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
Rise Time	t_r	—	5.0	—	μS	$I_C = 2 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	5.0	—	μS	$I_C = 2 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.50 \text{ mA}$, $E_e = 0.5 \text{ mW/cm}^2^{(6)}$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

PACKAGE DIMENSIONS



ST2143

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES COLLECTOR.

DESCRIPTION

The QSC133 is a silicon photodarlington encapsulated in an infrared transparent, black T-1 package.

FEATURES

- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Plastic package is infrared transparent and tinted to attenuate visible light.
- Mechanically and spectrally matched to the QECXXX LED.
- Black plastic body allows easy recognition from LED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

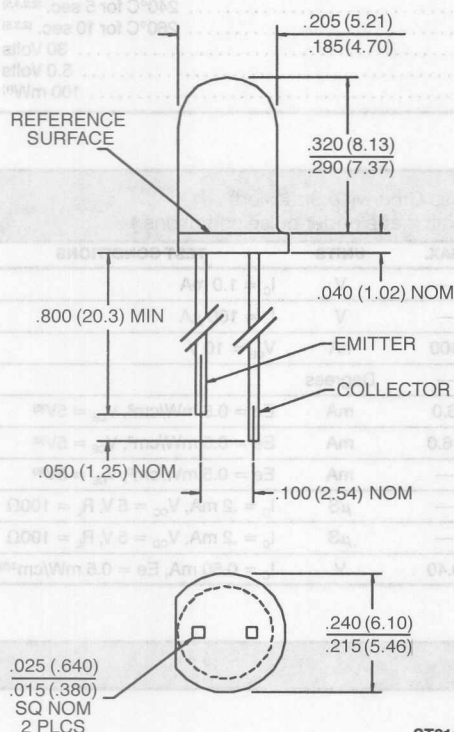
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1\text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 8	—	Degrees	
On-State Collector Current	$I_{C(ON)}$	8.0	—	—	mA	$E_e = 0.25\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}^{(6)}$
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	—	—	1.0	V	$I_C = 0.4\text{ mA}$, $E_e = 0.25\text{ mW/cm}^2^{(6)}$
Rise Time	t_r	—	20	—	μS	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	50	—	μS	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

QSD122/123/124

PACKAGE DIMENSIONS



NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES EMITTER.

DESCRIPTION

The QSD12X is a silicon phototransistor encapsulated in an infrared transparent, black T-1 $\frac{1}{2}$ package.

FEATURES

- Tight production distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow reception angle.
- Plastic package is infrared transparent black to attenuate visible light.
- Mechanically and spectrally matched to the QED123/222 LED.
- Black plastic body allows easy recognition from LED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. (2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

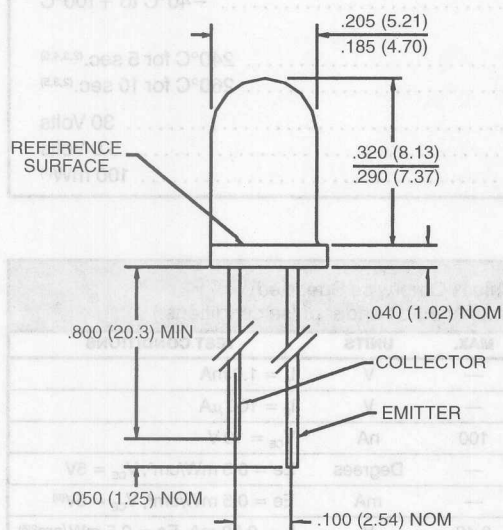
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0 \text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100 \mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10 \text{ V}$
Reception Angle at ½ Sensitivity	θ	—	± 12	—	Degrees	
On-State Collector Current QSD122	$I_{C(ON)}$	1.0	—	6.0	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5 \text{ V}^{(6)}$
On-State Collector Current QSD123	$I_{C(ON)}$	4.0	—	16.0	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5 \text{ V}^{(6)}$
On-State Collector Current QSD124	$I_{C(ON)}$	6.0	—	—	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5 \text{ V}^{(6)}$
Rise Time	t_r	—	7.0	—	μS	$I_C = .2 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	7.0	—	μS	$I_C = .2 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.50 \text{ mA}$, $E_e = 0.5 \text{ mW/cm}^2^{(6)}$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

PACKAGE DIMENSIONS

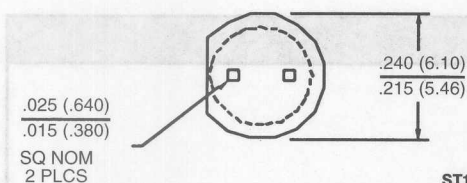


DESCRIPTION

The QSD128 is a phototransistor encapsulated in an infrared transparent, black T-1 $\frac{3}{4}$ package. The flat on the package indicates the collector lead.

FEATURE

- Steel lead frames for improved reliability in solder mounting
- Good optical-to-mechanical alignment
- Narrow reception angle
- Plastic package is infrared transparent black to attenuate visible light
- Mechanically and spectrally matched to the QED123/222 LED
- Black plastic body allows easy recognition from LED
- Low cost



NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25)
UNLESS OTHERWISE SPECIFIED.
3. FLAT DENOTES COLLECTOR.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0\text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 12	—	Degrees	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$
On-State Collector Current	$I_{C(ON)}$	1.60	—	—	mA	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}^{(6)}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	—	V	$I_C = 0.50\text{ mA}$, $E_e = 0.5\text{ mW/cm}^2^{(6)}$

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}"$ (1.6 mm) from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

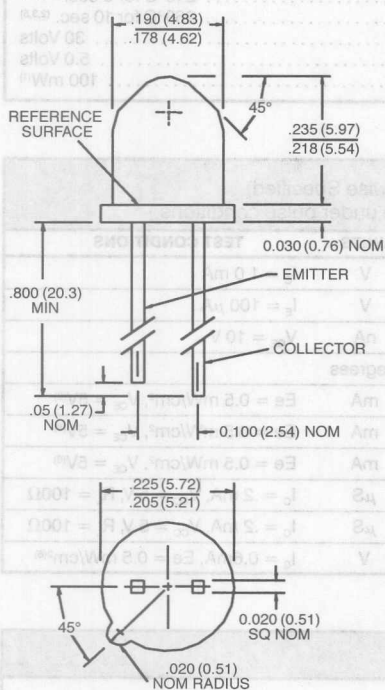
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0 \text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100 \mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10 \text{ V}$
Reception Angle at ½ Sensitivity	θ	—	±35	—	Degrees	
On-State Collector Current QSD422	$I_{C(ON)}$	0.3	—	1.8	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
On-State Collector Current QSD423	$I_{C(ON)}$	1.2	—	4.8	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
On-State Collector Current QSD424	$I_{C(ON)}$	1.8	—	—	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
Rise Time	t_r	—	8.0	—	μS	$I_C = .2 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	8.0	—	μS	$I_C = .2 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.15 \text{ mA}$, $E_e = 0.5 \text{ mW/cm}^2^{(6)}$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

QSD722/723/724

PACKAGE DIMENSIONS



ST2146

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. TAB DENOTES EMITTER.

DESCRIPTION

The QSD72X is a silicon phototransistor encapsulated in an infrared transparent, black TO-18 package.

FEATURES

- Tight production distribution.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow reception angle.
- Plastic package is infrared transparent black to attenuate visible light.
- Mechanically and spectrally matched to the QED423/523 LED.
- Black plastic body allows easy recognition from LED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

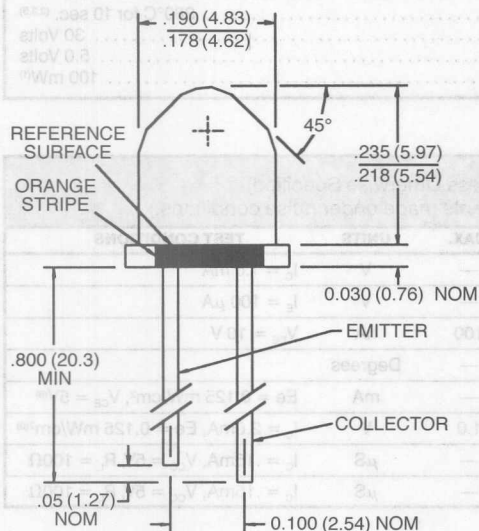
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0\text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 20	—	Degrees	
On-State Collector Current QSD722	$I_{C(ON)}$	0.6	—	3.8	mA	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}^{(6)}$
On-State Collector Current QSD723	$I_{C(ON)}$	2.5	—	10.0	mA	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}^{(6)}$
On-State Collector Current QSD724	$I_{C(ON)}$	3.5	—	—	mA	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}^{(6)}$
Rise Time	t_r	—	8.0	—	μS	$I_C = .2\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	8.0	—	μS	$I_C = .2\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.6\text{ mA}$, $E_e = 0.5\text{ mW/cm}^2^{(6)}$

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

PACKAGE DIMENSIONS

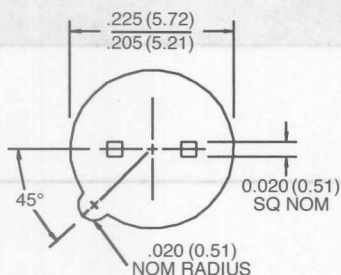


DESCRIPTION

The QSD733 is a silicon photodarlington encapsulated in an infrared transparent, black TO-18 package.

FEATURES

- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow reception angle.
- Plastic package is infrared transparent black to attenuate visible light.
- Mechanically and spectrally matched to the QED523 LED.
- Black plastic body allows easy recognition from LED.



ST2147

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. TAB DENOTES EMITTER.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

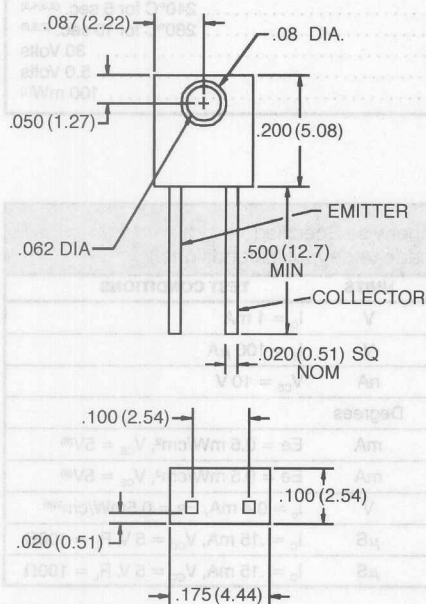
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0\text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 20	—	Degrees	
On-State Collector Current	$I_{C(ON)}$	5.0	—	—	mA	$E_e = 0.125\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁶⁾
Saturation Voltage	$V_{CE(SAT)}$	—	—	1.0	V	$I_C = 2.0\text{ mA}$, $E_e = 0.125\text{ mW/cm}^2$ ⁽⁶⁾
Rise Time	t_r	—	20	—	μs	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	50	—	μs	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

PACKAGE DIMENSIONS



ST2148

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QSE11X family is a silicon phototransistor encapsulated in a wide angle, infrared transparent, dark blue, plastic sidelooker shell package.

FEATURES

- Tight production distribution with min/max limits.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Plastic package is infrared transparent and tinted to attenuate visible light.
- Mechanically and spectrally matched to the QEE113 and QEE123 LEDs.
- Dark blue shell body allows easy recognition from LED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

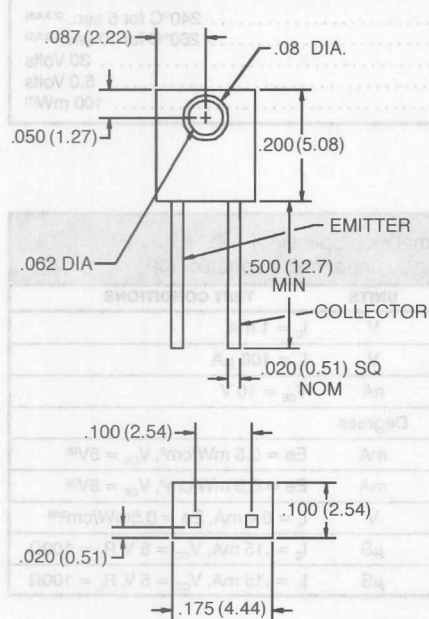
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1 \text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100 \mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10 \text{ V}$
Reception Angle at ½ Sensitivity	θ	—	± 25	—	Degrees	
On-State Collector Current QSE113	$I_{C(ON)}$	0.25	—	1.5	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
On-State Collector Current QSE114	$I_{C(ON)}$	1.0	—	—	mA	$E_e = 0.5 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	—	—	0.4	V	$I_C = 0.4 \text{ mA}$, $E_e = 0.5 \text{ mW/cm}^2^{(6)}$
Rise Time	t_r	—	8.0	—	μS	$I_C = .15 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	8.0	—	μS	$I_C = .15 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

PACKAGE DIMENSIONS



ST2149

DESCRIPTION

The QSE12X family is a silicon phototransistor encapsulated in a wide angle, infrared transparent, dark blue, plastic sidelooker shell package.

FEATURES

- High Sensitivity.
- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Plastic package is infrared transparent and tinted to attenuate visible light.
- Mechanically and spectrally matched to the QEE113 and QEE123 LEDs.
- Dark blue shell body allows easy recognition from LED.

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

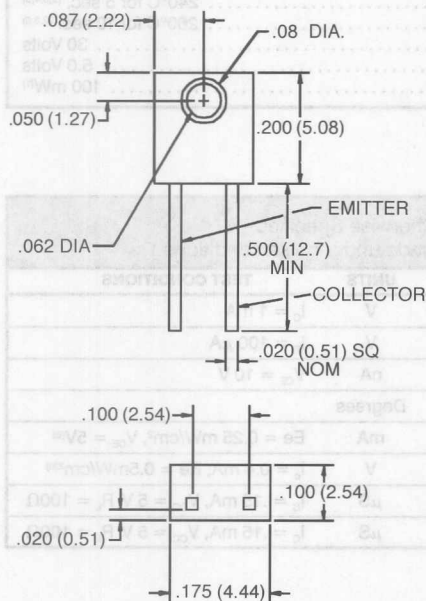
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1\text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 25	—	Degrees	
On-State Collector Current QSE122	$I_{C(ON)}$	3.0	—	12.0	mA	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁶⁾
On-State Collector Current QSE123	$I_{C(ON)}$	6.0	—	—	mA	$E_e = 0.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁶⁾
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	—	—	0.4	V	$I_C = 0.4\text{ mA}$, $E_e = 0.5\text{ mW/cm}^2$ ⁽⁶⁾
Rise Time	t_r	—	8.0	—	μS	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	8.0	—	μS	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

PACKAGE DIMENSIONS



ST2150

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QSE133 is a silicon photodarlington encapsulated in a wide angle, infrared transparent, dark blue, plastic sidelooker shell package.

FEATURES

- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Plastic package is infrared transparent and tinted to attenuate visible light.
- Mechanically and spectrally matched to the QEE113 and QEE123 LEDs.
- Dark blue shell body allows easy recognition from LED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

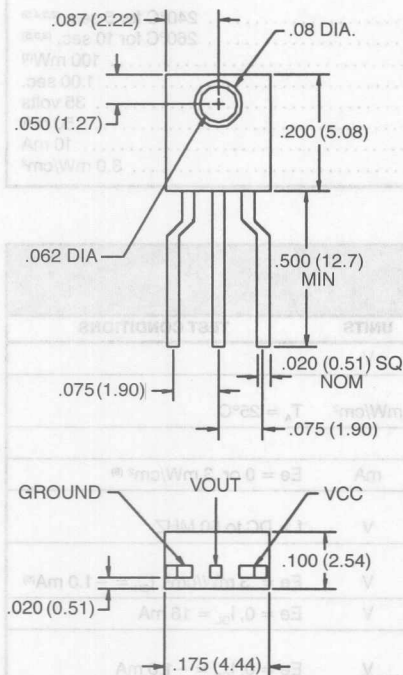
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30.0	—	—	V	$I_C = 1\text{ mA}$
Emitter-Collector Breakdown	BV_{ECO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 25	—	Degrees	
On-State Collector Current	$I_{C(ON)}$	9.0	—	—	mA	$E_e = 0.25\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}^{(6)}$
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	—	—	1.0	V	$I_C = 0.4\text{ mA}$, $E_e = 0.5\text{ mW/cm}^2^{(6)}$
Rise Time	t_r	—	20	—	μS	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	50	—	μS	$I_C = .15\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}"$ (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an AlGaAs LED emitting light at a peak wavelength of 880 nm.

QSE156/157/158/159

PACKAGE DIMENSIONS



NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QSE15X family are OPTOLOGIC™ ICs which feature a Schmitt trigger at output which provides hysteresis for noise immunity and pulse shaping. The basic building block of this IC consists of a photodiode, a linear amplifier, voltage regulator, Schmitt trigger and four output options. The TTL/LSTTL compatible output can drive up to ten TTL loads over supply currents from 4.5 to 16.0 volts. The dark red epoxy packaging system is designed to optimize the mechanical resolution, coupling efficiency, cost, and reliability.

FEATURES

- High noise immunity.
- Direct TTL/LSTTL interface.
- Steel lead frames for improved solder mounting.
- Reception angle of $\pm 25^\circ$.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Supply Voltage, V_{CC}	18 volts
Storage Temperature	$-40^\circ\text{C} + 100^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Power Dissipation	100 mW ⁽¹⁾
Duration of Output short to V_{CC}	1.00 sec.
Voltage at Output	35 volts
Sinking Current	50 mA
Sourcing Current (QSE156, QSE157)	10 mA
Irradiance	3.0 mW/cm^2

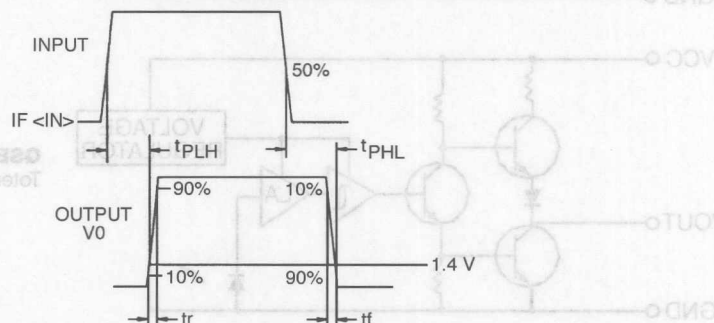
ELECTRICAL CHARACTERISTICS ($T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)
($V_{CC} = 4.5$ to 16 volts)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Operating Supply Voltage	V_{CC}	4.5		16.0	V	
Positive Going Threshold Irradiance ⁽⁶⁾	$E_e (+)$	0.025		0.250	mW/cm ²	$T_A = 25^\circ\text{C}$
Hysteresis Ratio	$E_e (+)/E_e (-)$	1.10		2.00		
Supply Current	I_{CC}	—		12.0	mA	$E_e = 0$ or $.3 \text{ mW/cm}^2$ ⁽⁶⁾
Peak to peak ripple which will cause false triggering		—		2.00	V	$f = \text{DC to } 50 \text{ MHz}$
QSE156 (BUFFER TOTEM POLE)						
High Level Output Voltage	V_{OH}	$V_{CC} - 2.1$		—	V	$E_e = .3 \text{ mW/cm}^2$, $I_{OH} = -1.0 \text{ mA}$ ⁽⁶⁾
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = 0$, $I_{OL} = 16 \text{ mA}$
QSE157 (INVERTER TOTEM POLE)						
High Level Output Voltage	V_{OH}	$V_{CC} - 2.1$		—	V	$E_e = 0$, $I_{OH} = -1.0 \text{ mA}$
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = .3 \text{ mW/cm}^2$, $I_{OL} = 16 \text{ mA}$ ⁽⁶⁾
QSE158 (BUFFER OPEN COLLECTOR)						
High Level Output Current	I_{OH}	—		100	μA	$E_e = .3 \text{ mW/cm}^2$, $V_{OH} = 30 \text{ V}$ ⁽⁶⁾
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = 0$, $I_{OL} = 16 \text{ mA}$
QSE159 (INVERTER OPEN COLLECTOR)						
High Level Output Current	I_{OH}	—		100	μA	$E_e = 0$, $V_{OH} = 30 \text{ V}$
Low Level Output Voltage	V_{OL}	—		0.40	V	$E_e = .3 \text{ mW/cm}^2$, $I_{OL} = 16 \text{ mA}$ ⁽⁶⁾

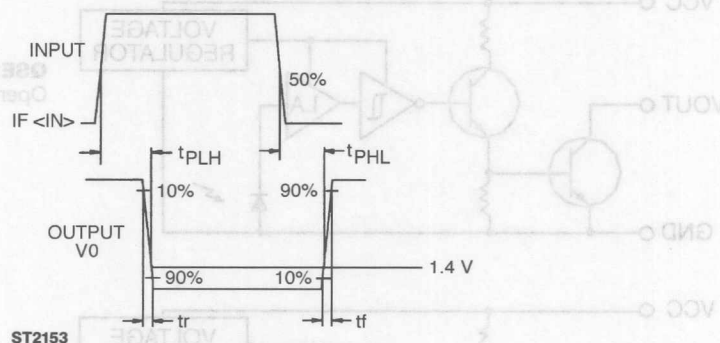
ELECTRICAL CHARACTERISTICS ($T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)
($V_{CC} = 4.5$ to 16 volts)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
QSE156, QSE157						
Output rise, fall times	t_r, t_f	—		70	nS	$E_e = 0$ or $.3 \text{ mW/cm}^2$, $f = 10 \text{ K Hz}$ $\text{DC} = 50\%$, $R_L = 10 \text{ TTL loads}^{(6)}$
Propagation delay	t_{phl}, t_{plh}		6.0		μS	
QSE158, QSE159						
Output rise, fall times	t_r, t_f	—		100	nS	$E_e = 0$ or $.3 \text{ mW/cm}^2$, $f = 10 \text{ K Hz}$ $\text{DC} = 50\%$, $R_L = 300\Omega^{(6)}$
Propagation delay	t_{phl}, t_{plh}		6.0		μS	

Switching Test Curve for Buffers



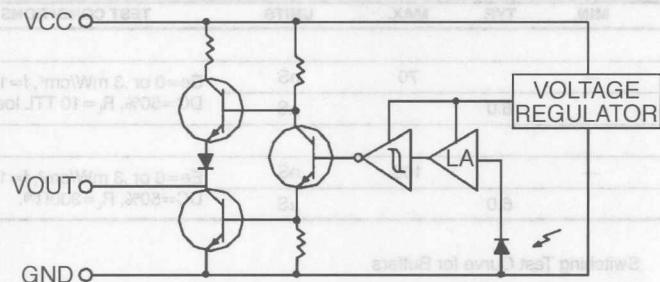
Switching Test Curve for Inverters



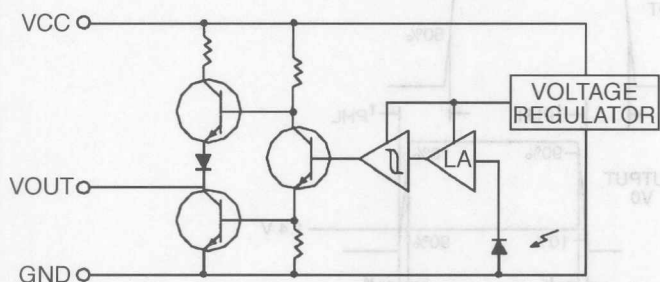
NOTES

1. Derate power dissipation linearly $4.00 \text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Irradiance measurements are made with an AlGaAs LED emitting light at a peak wavelength of 880 nm .

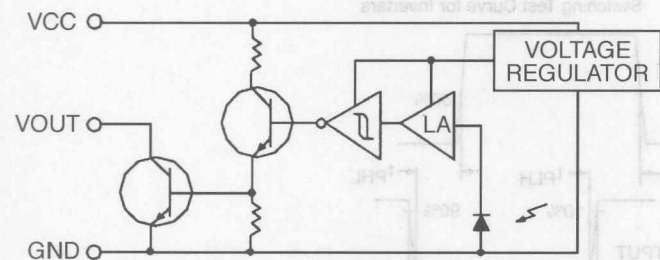
CIRCUIT SCHEMATICS



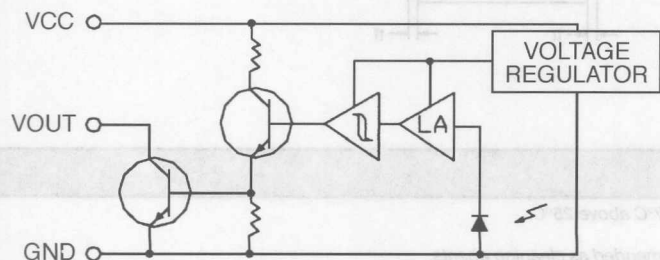
QSE156
Totem-Pole Output Buffer



QSE157
Totem-Pole Output Inverter

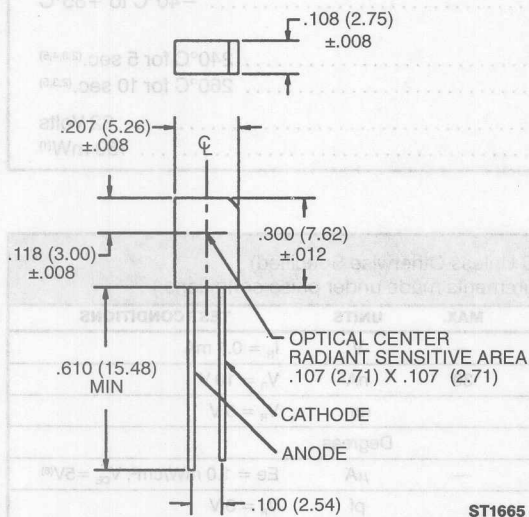


QSE158
Open-Collector Output Buffer



QSE159
Open-Collector Output Inverter

PACKAGE DIMENSIONS



DESCRIPTION

The QSE773 is a silicon PIN photodiode encapsulated in an infrared transparent, black, plastic sidelooker package.

FEATURES

- High sensitivity
- Low cost
- Plastic package is infrared transparent and tinted to attenuate visible light

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Reverse Voltage	32 Volts
Power Dissipation	150 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

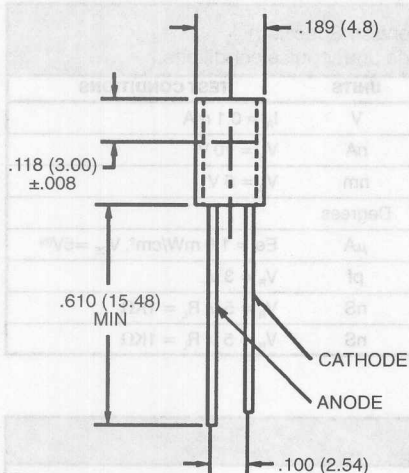
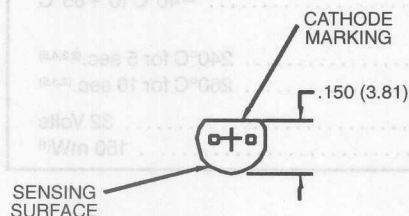
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Reverse Voltage	V_R	32		—	V	$I_R = 0.1\text{ mA}$
Dark Reverse Current	$I_{R(D)}$	—		30	nA	$V_R = 10\text{ V}$
Peak Sensitivity	λ_{pk}		930		nm	$V_R = 5\text{ V}$
Reception Angle at $\frac{1}{2}$ Power	θ		± 60		Degrees	
Photosensitivity	S	30		—	μA	$E_e = 1.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁶⁾
Capacitance	C		20		pf	$V_R = 3\text{ V}$
Rise Time	t_r		50		nS	$V_R = 5\text{ V}$, $R_L = 1\text{ K}\Omega$
Fall Time	t_f		50		nS	$V_R = 5\text{ V}$, $R_L = 1\text{ K}\Omega$

NOTES

1. Derate power dissipation linearly $2.50\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an GaAs LED emitting light at a peak wavelength of 940 nm.

PACKAGE DIMENSIONS



ST1666

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).

DESCRIPTION

The QSE973 is a silicon PIN photodiode encapsulated in an infrared transparent, black, plastic sidelooper package.

FEATURES

- High sensitivity
- Low cost
- Plastic package is infrared transparent and tinted to attenuate visible light

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to +85°C
Operating Temperature	-40°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Reverse Voltage	32 Volts
Power Dissipation	150 mW ⁽¹⁾

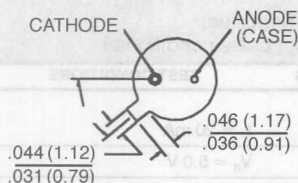
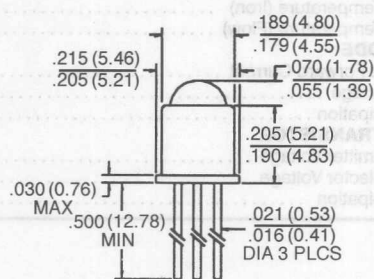
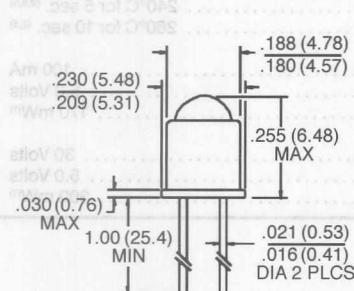
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Reverse Voltage	V_R	32		—	V	$I_R = 0.1 \text{ mA}$
Dark Reverse Current	$I_{R(D)}$	—		30	nA	$V_R = 10 \text{ V}$
Peak Sensitivity	λ_{pk}		930		nm	$V_R = 5 \text{ V}$
Reception Angle at ½ Power	θ		± 45		Degrees	
Photosensitivity	S	30		—	μA	$E_e = 1.0 \text{ mW/cm}^2$, $V_{CE} = 5\text{V}^{(6)}$
Capacitance	C		20		pf	$V_R = 3 \text{ V}$
Rise Time	t_r		50		nS	$V_R = 5 \text{ V}$, $R_L = 1\text{K}\Omega$
Fall Time	t_f		50		nS	$V_R = 5 \text{ V}$, $R_L = 1\text{K}\Omega$

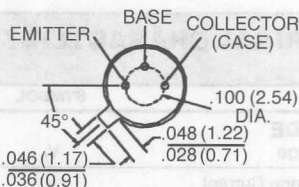
NOTES

1. Derate power dissipation linearly 2.50 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is an GaAs LED emitting light at a peak wavelength of 940 nm.

PACKAGE DIMENSIONS



INFRARED LED



PHOTOTRANSISTOR

ST2137

ST2137

- NOTES:
1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25)
UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QPA1223 consists of an 880 nm AlGaAs LED and a silicon phototransistor mounted in TO-46 (LED) and TO-18 (sensor) metal can packages.

FEATURE

- Narrow emission/reception angle.
- Hermetically sealed packages.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to $+150^\circ\text{C}$
Operating Temperature	-65°C to $+125^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,5)
INPUT DIODE	
Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	170 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	300 mW ⁽¹⁾

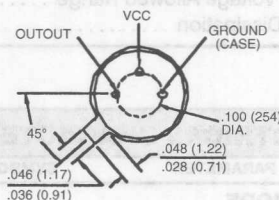
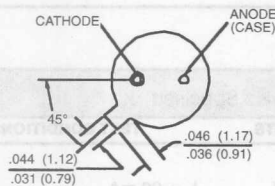
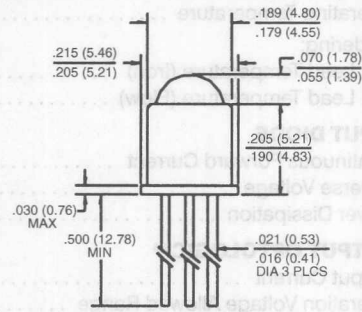
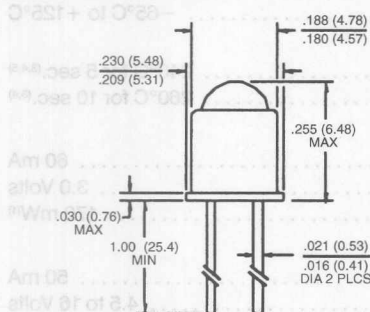
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 5.0\text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_F = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QPA1223	$I_{C(ON)}$	7.5		—	mA	$I_F = 20\text{ mA}$, $V_{CC} = 5.0\text{ V}$, $D = .250''^{(4)}$

NOTES

1. Derate power dissipation linearly $1.70\text{ mW}/^\circ\text{C}$ above 25°C for input diode; $3.00\text{ mW}/^\circ\text{C}$ for output transistor.
2. RMA flux is recommended.
3. Soldering iron tip $\frac{1}{16}''$ (1.6 mm) minimum from case.
4. D is the distance from lens tip to lens tip.
5. As long as leads are not under any stress or spring tension.

PACKAGE DIMENSIONS



ST1660

INFRARED LED

ST1661

PHOTOSENSOR

- NOTES:
1. DIMENSIONS ARE IN INCHES [mm].
2. TOLERANCE IS ± 0.010 [.25]
UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QPA8259 consists of an 880nm AlGaAs LED and an OPTOLOGIC™ silicon photosensor mounted in hermetically sealed packages.

FEATURE

- Narrow emission/reception angle
- Hermetically sealed packages

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to $+150^\circ\text{C}$
Operating Temperature	-65°C to $+125^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	3.0 Volts
Power Dissipation	170 mW ⁽¹⁾

OUTPUT OPTOLOGIC™

Output Current	50 mA
Operation Voltage Allowed Range	4.5 to 16 Volts
Output Voltage Allowed Range	4.5 to 16 Volts
Power Dissipation	250 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

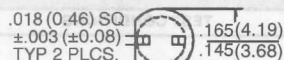
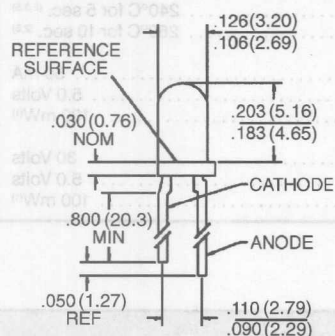
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
OUTPUT OPTOLOGIC™						
Operating Supply Voltage	V_{CC}	4.5		16.0	V	
Supply Current	I_{CC}	—		12.0	mA	$E_o = 0$ or 0.3 mW/cm^2
Output Current High	I_{OH}	—		10	μA	$E_o = 0$, $V_{OH} = 30 \text{ V}$
Low Level Output Voltage	V_{OL}	—		0.4	V	$E_o = .3 \text{ mW/cm}^2$, $R_L = 270\Omega$
COUPLED						
Turn-On Threshold Current	$I_{F(+)}$	—		20.0	mA	$V_{CC} = 5 \text{ V}$, $R_L = 270\Omega$, $D = .250''^{(6)}$
Turn-Off Threshold Current	$I_{F(-)}$	1.0		—	mA	$V_{CC} = 5 \text{ V}$, $R_L = 270\Omega$, $D = .250''^{(6)}$
Hysteresis Ratio	$I_{F(+)} / I_{F(-)}$	1.1		2.0		$V_{CC} = 5 \text{ V}$, $R_L = 270\Omega$, $D = .250''^{(6)}$

NOTES

1. Derate power dissipation linearly $1.70 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.50 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16''$ (1.6 mm) from housing.
6. D is the distance from lens tip to lens tip.

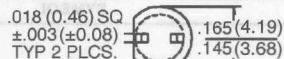
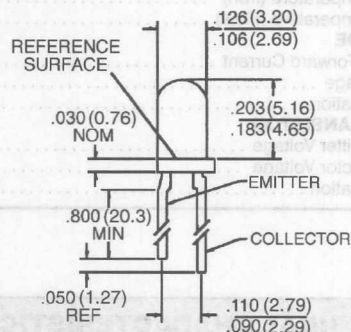
QPC1213

PACKAGE DIMENSIONS



INFRARED LED

ST2138



PHOTOTRANSISTOR

ST2138

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS ± 0.010 (.25) UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QPC1213 consists of an 880 nm AlGaAs LED and a silicon phototransistor mounted in plastic T-1 packages.

FEATURE

- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow emission/reception angle.
- Black plastic body allows easy recognition of sensor.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,5)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

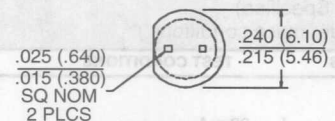
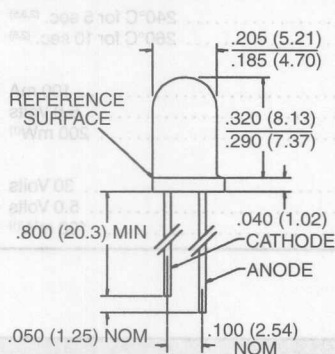
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—	1.70		V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100		μA	$V_R = 5.0 \text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{CEO}	30	—		V	$I_F = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100		nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QPC1213	$I_{C(ON)}$	5.0	—		mA	$I_F = 20 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$, $D = .250''^{(4)}$

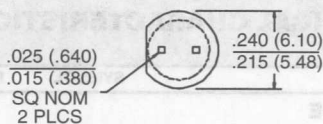
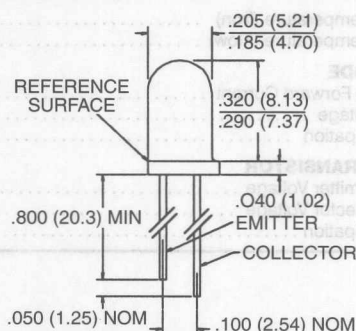
NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Soldering iron tip $\frac{1}{16}''$ (1.6 mm) minimum from case.
4. D is the distance from lens tip to lens tip.
5. As long as leads are not under any stress or spring tension.

PACKAGE DIMENSIONS



ST2169



ST2169

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS ± 0.010 (.25) UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QPD1223 consists of an 880 nm AlGaAs LED and a silicon phototransistor mounted in plastic T-1 1/4 packages.

FEATURE

- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow emission/reception angle.
- Black plastic body allows easy recognition of sensor.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,5)

INPUT DIODE

Continuous Forward Current	100 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

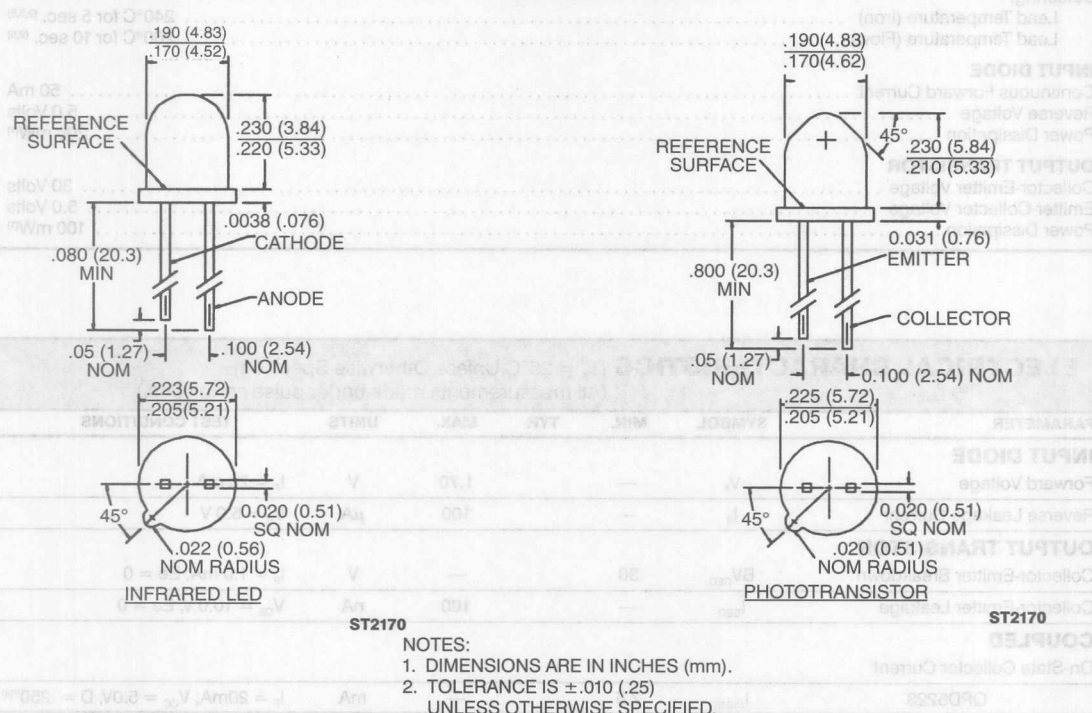
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—	1.70		V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—	100		μA	$V_R = 5.0\text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{CEO}	30	—		V	$I_F = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100		nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QPD1223	$I_{C(ON)}$	10.0	—		mA	$I_F = 20\text{ mA}$, $V_{CC} = 5.0\text{ V}$, $D = .250''^{(4)}$

NOTES

1. Derate power dissipation linearly $2.67\text{ mW}/^\circ\text{C}$ above 25°C for LED and $1.33\text{ mW}/^\circ\text{C}$ for sensor.
2. RMA flux is recommended.
3. Soldering iron tip $\frac{1}{16}''$ (1.6mm) minimum from case.
4. D is the distance from lens tip to lens tip.
5. As long as leads are not under any stress or spring tension.

PACKAGE DIMENSIONS



DESCRIPTION

The QPD5223 consists of an 880 nm AlGaAs LED and a silicon phototransistor mounted in plastic TO-46 (LED) and TO-18 (sensor) packages.

FEATURE

- Steel lead frames for improved reliability in solder mounting.
- Good optical-to-mechanical alignment.
- Narrow emission/reception angle.
- Black plastic body allows easy recognition of sensor.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,5)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	200 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

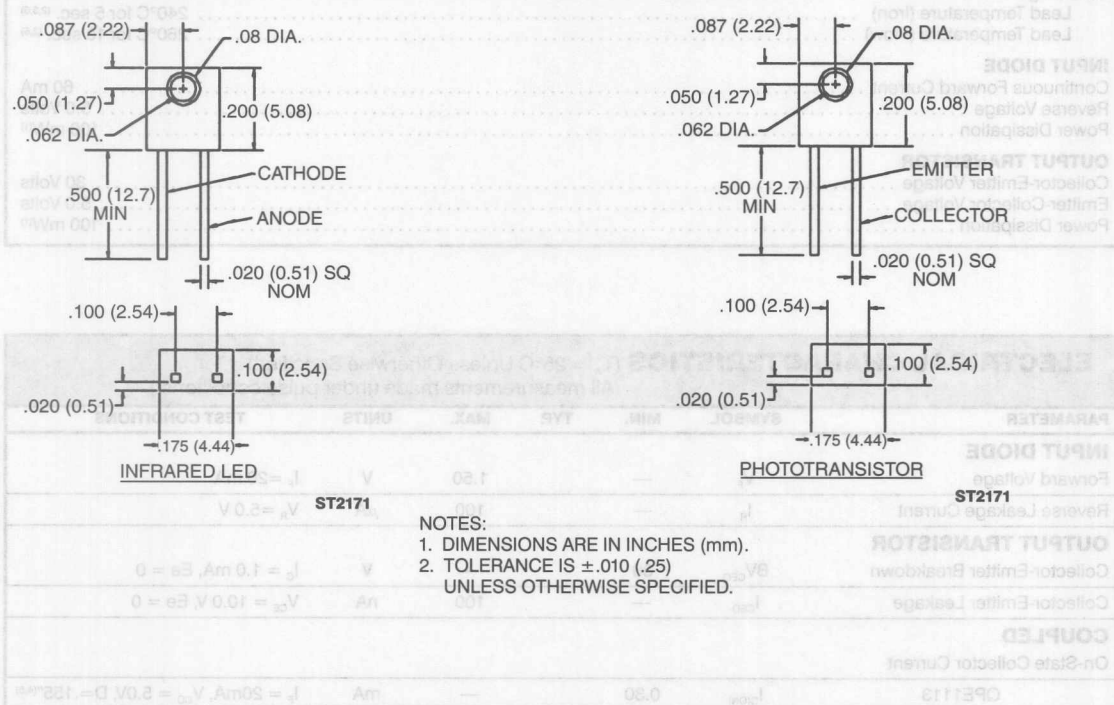
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—	1.70		V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—	100		μA	$V_R = 5.0\text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{CEO}	30	—		V	$I_F = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100		nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QPD5223	$I_{C(ON)}$	7.5	—		mA	$I_F = 20\text{ mA}$, $V_{CC} = 5.0\text{ V}$, $D = .250''^{(4)}$

NOTES

1. Derate power dissipation linearly $2.67\text{ mW}/^\circ\text{C}$ above 25°C for LED and $1.33\text{ mW}/^\circ\text{C}$ for the sensor.
2. RMA flux is recommended.
3. Soldering iron tip $1/16''$ (1.6mm) minimum from case.
4. D is the distance from lens tip to lens tip.
5. As long as leads are not under any stress or spring tension.

PACKAGE DIMENSIONS



DESCRIPTION

The QPE1113 consists of a 940nm GaAs LED and a silicon phototransistor mounted in plastic sidelooker packages.

FEATURE

- Steel lead frames for improved reliability in solder mounting.
- Excellent optical-to-mechanical alignment.
- Wide emission/reception angle.
- Black plastic body allows easy recognition of sensor and filters ambient visible light.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,5)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

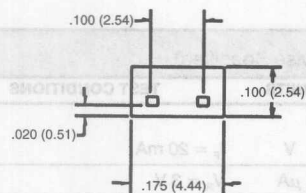
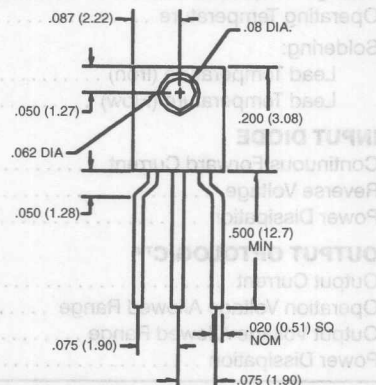
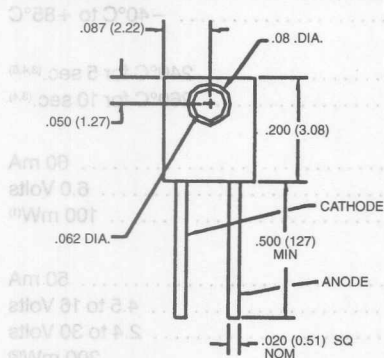
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.50	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 5.0\text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{CEO}	30			V	$I_C = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QPE1113	$I_{C(ON)}$	0.30		—	mA	$I_F = 20\text{ mA}$, $V_{CC} = 5.0\text{ V}$, $D = .155''^{(4,5)}$

NOTES

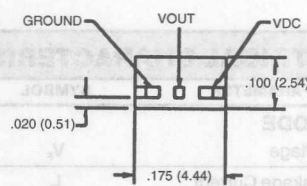
1. Derate power dissipation linearly 133 mW/ $^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Soldering iron tip $\frac{1}{16}''$ (1.6mm) minimum from case.
4. D is the distance from lens tip to lens tip.
5. As long as leads are not under any stress or spring tension.

PACKAGE DIMENSIONS



INFRARED LED

ST1662



PHOTOSENSOR

ST1663

NOTES:

1. DIMENSIONS ARE IN INCHES [mm].
2. TOLERANCE IS $\pm .010$ [.25] UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QPE1259 consists of a gallium arsenide LED and an OPTOLOGIC™ silicon photosensor mounted in plastic sidelooker packages.

FEATURE

- Steel lead frames for improved reliability in solder mounting
- Excellent optical-to-mechanical alignment
- Wide emission/reception angle
- Black plastic body allows easy recognition of sensor and filters ambient visible light

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT OPTOLOGIC™

Output Current	50 mA
Operation Voltage Allowed Range	4.5 to 16 Volts
Output Voltage Allowed Range	2.4 to 30 Volts
Power Dissipation	200 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

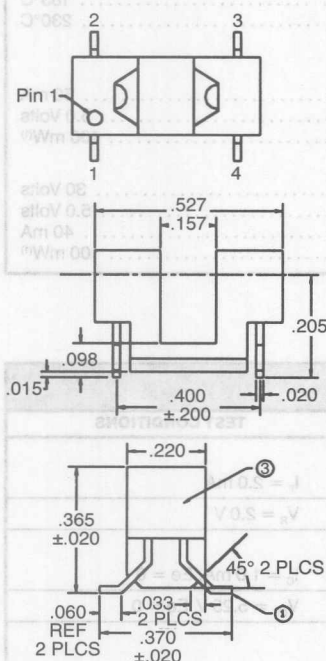
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.5	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
OUTPUT OPTOLOGIC™						
Operating Supply Voltage	V_{CC}	4.5		16.0	V	
Supply Current	I_{CC}	—		12.0	mA	$E_o = 0$ or 0.3 mW/cm^2
Output Current High	I_{OH}	—		100	μA	$E_o = 0$, $V_{OH} = 30 \text{ V}$
Low Level Output Voltage	V_{OL}	—		0.4	V	$E_o = .3 \text{ mW/cm}^2$, $R_L = 270\Omega$
COUPLED						
Turn-On Threshold Current	$I_{F(+)}$	—		20.0	mA	$V_{CC} = 5 \text{ V}$, $R_L = 270\Omega$, $D = .155''^{(6)}$
Turn-Off Threshold Current	$I_{F(-)}$	1.0		—	mA	$V_{CC} = 5 \text{ V}$, $R_L = 270\Omega$, $D = .155''^{(6)}$
Hysteresis Ratio	$I_{F(+)} / I_{F(-)}$	1.1		2.0		$V_{CC} = 5 \text{ V}$, $R_L = 270\Omega$, $D = .155''^{(6)}$

NOTES

1. Derate power dissipation linearly $1.67 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $3.33 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16''$ (1.6 mm) from housing.
6. D is the distance from lens tip to lens tip.

QCK3/QCK4 SURFACE MOUNTABLE OPTO INTERRUPTER

PACKAGE DIMENSIONS



ST2168

PIN OUT:

- 1 - ANODE
2 - CATHODE
3 - COLLECTOR
4 - EMITTER

NOTES:

1. ALL LEADS ARE CO-PLANAR WITHIN .006".
2. UNLESS SPECIFIED, GENERAL TOLERANCE IS $\pm .010$ ".
3. HOUSING MATERIAL IS ELECTRICALLY CONDUCTIVE.

DESCRIPTION

The QCK3/QCK4 is a slotted optical switch designed for surface mount applications where extreme temperatures are experienced during solder reflow. The switch consists of a GaAs LED and a silicon photodarlington facing each other across a .157" (4.0 mm) gap. The leads are formed to sit flush on a PCB during solder reflow.

FEATURES

- Unique single piece housing designed to reduce cost.
- High temperature housing material to withstand extreme temperature.
- High current transfer ratios (CTR) for low drive current at extreme temperature.
- Shipped in plastic tubes for protection of leads and to feed automatic placement equipment.
- Sensor package is infrared transparent and tinted to attenuate visible light.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Surface mount soldering temperature: (IR reflow solder chamber)	
Pre-heating stage 60 seconds max.	183°C
Reflow stage 5 seconds max.	230°C

NOTE: The rate of temperature rise shall be between 3°C and 10°C per second.

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	40 mA
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.40	V	$I_F = 2.0 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0 \text{ mA}, E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		30	μA	$V_{CE} = 5.25 \text{ V}, E_e = 0$
COUPLED						
On-State Collector Current						
QCK3	$I_{C(ON)}$	1.0		—	mA	$I_F = 5.0 \text{ mA}, V_{CC} = 5.0 \text{ V}$
QCK4	$I_{C(ON)}$	3.0		15.0	mA	$I_F = 5.0 \text{ mA}, V_{CC} = 5.0 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		1.0	V	$I_F = 5.0 \text{ mA}, I_C = 5.0 \text{ mA}$

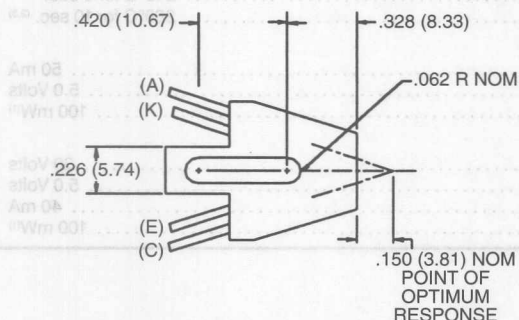
NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.

QRB1113/1114

3

PACKAGE DIMENSIONS



DESCRIPTION

The QRB1113/1114 consists of an infrared emitting diode and an NPN silicon phototransistor mounted side by side on a converging optical axis in a black plastic housing. The phototransistor responds to radiation from the emitting diode only when a reflective object passes within its field of view. The area of the optimum response approximates a circle .200" in diameter.

FEATURES

- Phototransistor output
- High Sensitivity
- Low cost plastic housing
- IR transparent plastic covers for dust protection.

PARAMETER	SYMBOL	UNIT	MIN	TYP	MAX
Forward Voltage	V_F	V	—	1.70	—
Reverse Leakage Current	I_R	μA	—	100	—
Emitter-Collector Breakdown	BV_{EC}	V	—	5	—
Collector-Emitter Breakdown	BV_{CE}	V	—	30	—
Collector-Emitter Leakage	I_{CE}	nA	—	100	—
On-State Collector Current	I_C	mA	—	0.50	—
QRB1113					
QRB1114					
Cross-talk					
Saturation Voltage	$V_{CE(sat)}$	V	—	4	—

FUNCTION	TEST CONDITIONS	UNIT	MIN	TYP	MAX
(C) COLLECTOR	$I_C = 40 \text{ mA}, V_{CE} = 5 \text{ V}$	mA	—	—	—
(E) EMITTER	$I_E = 40 \text{ mA}, V_{CE} = 5 \text{ V}$	mA	—	—	—
(K) CATHODE	$I_C = 40 \text{ mA}, V_{CE} = 5 \text{ V}$	mA	—	—	—
(A) ANODE	$I_C = 40 \text{ mA}, V_{CE} = 5 \text{ V}$	mA	—	—	—

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010"$ (.25)
- UNLESS OTHERWISE SPECIFIED.

NOTES
1. Data power dissipation linearly 1.87 mW/C above 25°C.
2. RMA flux is recommended.
3. Methylal or isopropyl alcohol are recommended as cleaning agents.
4. Soldering iron (450°C) for 10 seconds.
5. D is the distance from the assembly face to the reflecting surface.
6. Measured using Eastman Kodak neutral test card with 80% diffused reflecting surface.
7. Cross talk is the photocurrent measured with current to the input diode and no reflecting surface.

QRB1113/1114

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	40 mA
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 40 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QRB1113	$I_{C(ON)}$	0.20		—	mA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,6)
QRB1114	$I_{C(ON)}$	0.60		3.00	mA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,6)
Crosstalk	I_{CX}	—		1.00	μA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$ ⁽⁷⁾
Saturation Voltage	$V_{CE(SAT)}$	—		.4	V	$I_F = 40 \text{ mA}$, $I_C = 0.1 \text{ mA}$, $D = .150''$ ^(5,6)

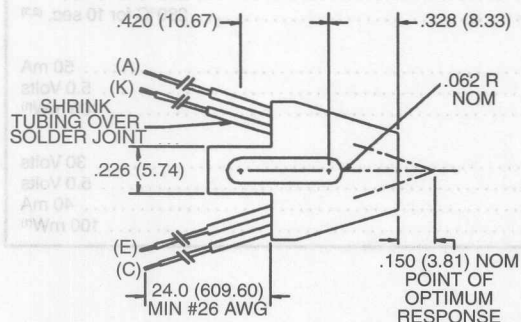
NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron $\frac{1}{16}''$ (1.6mm) from housing
5. D is the distance from the assembly face to the reflective surface.
6. Measured using Eastman Kodak neutral test card with 90% diffused reflecting surface.
7. Cross talk is the photocurrent measured with current to the input diode and no reflecting surface.

QRB1133/1134

3

PACKAGE DIMENSIONS



DESCRIPTION

The QRB1133/1134 consists of an infrared emitting diode and an NPN silicon phototransistor mounted side by side on a converging optical axis in a black plastic housing. The phototransistor responds to radiation from the emitting diode only when a reflective object passes within its field of view. The area of the optimum response approximates a circle .200" in diameter.

FEATURES

- Phototransistor output
- High Sensitivity
- Low cost plastic housing
- #26 AWG, 24 inch PVC wire termination
- Infrared transparent plastic covers for dust protection.

FUNCTION		WIRE COLOR	
(C) COLLECTOR		WHITE	
(E) EMITTER		BLUE	
(K) CATHODE		GREEN	
(A) ANODE		ORANGE	

PARAMETER	UNIT	MAX.	MIN.
Forward Voltage	V	1.70	—
Reverse Leakage Current	μA	100	—
Emitter-Collector Breakdown	BV _{EC}	5	—
Collector-Emitter Breakdown	BV _{CE}	30	—
Collector-Emitter Leakage	I _{CE}	100	—
On-State Collector Current	I _C	0.50	—

QRB1133	QRB1134
0.50	0.50
0.00	0.00
1.00	1.00
0.40	0.40

- NOTES:
1. DIMENSIONS ARE IN INCHES (mm).
 2. TOLERANCE IS ±.010" (.25) UNLESS OTHERWISE SPECIFIED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	40 mA
Power Dissipation	100 mW ⁽¹⁾

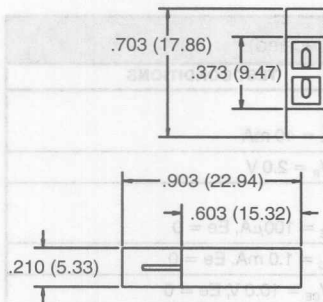
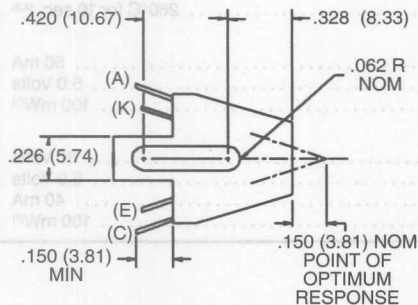
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 40 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
QRB1133	$I_{C(ON)}$	0.20		—	mA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,7)
QRB1134	$I_{C(ON)}$	0.60		3.00	mA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,7)
Crosstalk	I_{CX}	—		1.00	μA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$ ⁽⁶⁾
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 40 \text{ mA}$, $I_C = 0.1 \text{ mA}$, $D = .150''$ ^(5,7)

NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropanol alcohols are recommended as cleaning agents.
- Soldering iron 1/16" (1.6mm) from housing
- D is the distance from the assembly face to the reflective surface.
- Cross talk is the photocurrent measured with current to the input diode and no reflecting surface.
- Measured using Eastman Kodak neutral test card with 90% diffused reflecting surface.

PACKAGE DIMENSIONS



ST2178

(C) COLLECTOR
(E) EMITTER
(K) CATHODE
(A) ANODE

NOTES:

1. CATHODE AND EMITTER LEADS ARE .050 NOM SHORTER THAN ANODE AND COLLECTOR LEADS.
2. DIMENSIONS ARE IN INCHES (mm).
3. TOLERANCE IS $\pm .010$ [.25] UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QRC1113 consists of an infrared emitting diode and an NPN silicon phototransistor mounted side by side on a converging optical axis in a black plastic housing. The phototransistor responds to radiation from the emitting diode only when a reflective object passes within its field of view. The area of the optimum response approximates a circle .200" in diameter.

FEATURES

- Phototransistor output
- High Sensitivity
- Low cost plastic housing

PARAMETER	UNIT	MAX.	TYP.	MIN.
INPUT DIODE				
Forward Voltage	V	1.70	—	—
Reverse Leakage Current	μ A	100	—	—
OUTPUT TRANSISTOR				
Emitter-Collector Breakdown	V _{CE}	—	5	—
Collector-Emitter Breakdown	V _{CE}	—	30	—
Collector-Emitter Leakage	μ A	100	—	—
COUPLED				
On-State Collector Current	mA	—	200	—
Cross-talk	μ A	1.0	—	—
Saturation Voltage	V _{CE(sat)}	0.40	—	—

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	40 mA
Power Dissipation	100 mW ⁽¹⁾

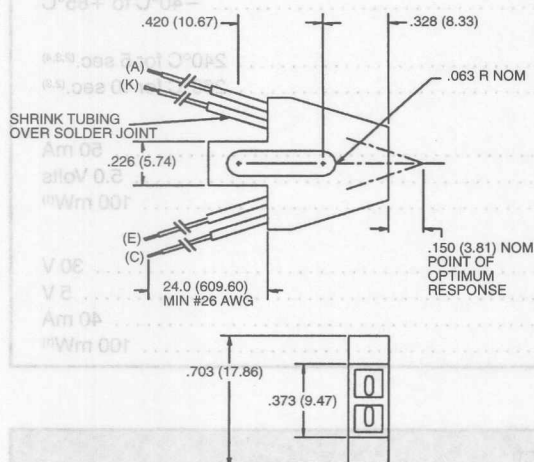
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 40\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0\text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	.200		—	mA	$I_F = 40\text{ mA}$, $V_{CE} = 5\text{ V}$, $D = .150''^{(5,7)}$
Crosstalk	I_{CX}	—	1.0		μA	$I_F = 40\text{ mA}$, $V_{CE} = 5\text{ V}^{(6)}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40		V	$I_F = 40\text{ mA}$, $I_C = .1\text{ mA}$, $D = .150''^{(5,7)}$

NOTES

1. Derate power dissipation linearly $1.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron $1/16''$ (1.6mm) from housing.
5. D is the distance from the assembly face to the reflective surface.
6. Cross talk is the photocurrent measured with current to the input diode and no reflecting surface.
7. Measured using Eastman Kodak neutral test card with 90% diffused reflecting surface.

PACKAGE DIMENSIONS



DESCRIPTION

The QRC1133 consists of an infrared emitting diode and an NPN silicon phototransistor mounted side by side on a converging optical axis in a black plastic housing. The phototransistor responds to radiation from the emitting diode only when a reflective object passes within its field of view. The area of optimum response approximates a circle .200" in diameter.

FEATURES

- Phototransistor output
- High Sensitivity
- Low cost plastic housing
- #26 AWG, 24 inch PVC wire termination

PARAMETER	SYMBOL	UNIT	MAX	TEST CONDITIONS
INPUT DIODE				
Forward Voltage	V _F	V	1.70	I _F = 10 mA
Reverse Leakage Current	I _R	μA	100	V _R = 5 V
OUTPUT TRANSISTOR				
Emitter-Collector Breakdown	BV _{EC}	V	30	I _E = 10 mA, I _C = 0
Collector-Emitter Breakdown	BV _{CE}	V	30	I _E = 0, I _C = 10 mA
Collector-Emitter Leakage	I _{CE}	μA	100	V _{CE} = 5 V, I _B = 0
COUPLED				
On-State Collector Current	I _{ON}	mA	0.50	V _{CE} = 5 V, I _B = 0
Crosstalk	I _{CR}	μA	1.00	V _{CE} = 5 V, I _B = 0
Saturation Voltage	V _{CE(sat)}	V	0.40	I _C = 10 mA, I _B = 0.1 mA

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS ±.010 (.25) UNLESS OTHERWISE SPECIFIED.

QRC1133

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to +85°C
Operating Temperature	-40°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 V
Emitter-Collector Voltage	5 V
Collector Current	40 mA
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

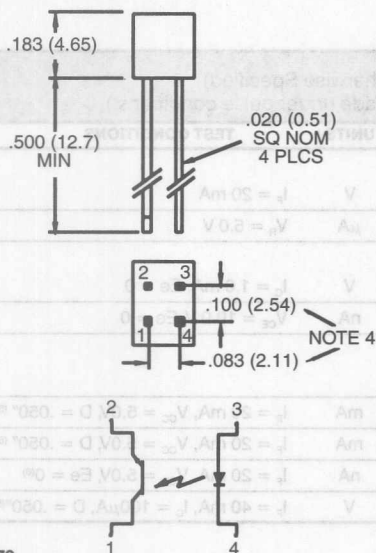
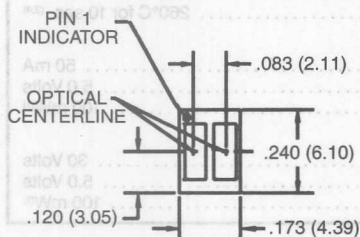
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 40 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{CEO}	5		—	V	$I_E = 100 \mu\text{A}$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0 \text{ mA}$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0 \text{ V}$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	0.20		—	mA	$I_F = 40 \text{ mA}, V_{CE} = 5 \text{ V}, D = .150''^{(5,7)}$
Crosstalk	I_{CX}	—		1.00	μA	$I_F = 40 \text{ mA}, V_{CE} = 5 \text{ V}^{(6)}$
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 40 \text{ mA}, I_C = 0.1 \text{ mA}, D = .150''$

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}''$ (1.6 mm) from housing.
5. D is the distance from the assembly face to the reflective surface.
6. Cross talk is the photocurrent measured with current to the input diode and no reflecting surface.
7. Measured using Eastman Kodak neutral test card with 90% diffused reflecting surface.

QRD1113/1114

PACKAGE DIMENSIONS



ST2172

DESCRIPTION

The QRD1113/1114 reflective sensors consist of an infrared emitting diode and an NPN silicon phototransistor mounted side by side in a black plastic housing. The on-axis radiation of the emitter and the on-axis response of the detector are both perpendicular to the face of the QRD1113/1114. The phototransistor responds to radiation emitted from the diode only when a reflective object or surface is in the field of view of the detector.

FEATURES

- Phototransistor output.
- Unfocused for sensing diffused surfaces.
- Low cost plastic housing.
- Designed for paper path and other non-contact surface sensing.

NOTES:

1. PINS 2 AND 4 TYPICALLY .050" SHORTER THAN PINS 1 AND 3
2. DIMENSIONS ARE IN INCHES (mm).
3. TOLERANCE IS $\pm .010$ [.25] UNLESS OTHERWISE SPECIFIED.
4. THESE DIMENSIONS ARE CONTROLLED AT HOUSING SURFACE.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+100^\circ\text{C}$
Operating Temperature	-40°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,4)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified) (All measurements made under pulse conditions.)

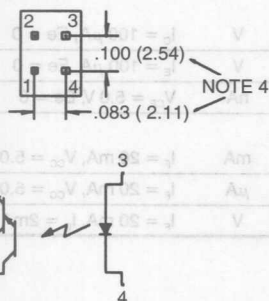
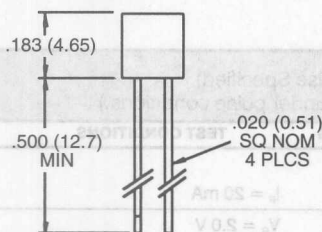
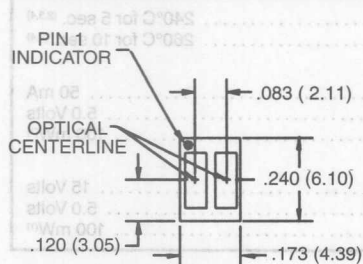
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V _F	—		1.70	V	I _F = 20 mA
Reverse Leakage Current	I _R	—		100	μA	V _R = 5.0 V
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV _{CEO}	30		—	V	I _C = 1.0 mA, E _e = 0
Collector-Emitter Leakage	I _{CEO}	—		100	nA	V _{CE} = 10.0 V, E _e = 0
COUPLED						
On-State Collector Current						
QRD1113	I _{C(ON)}	0.30		—	mA	I _F = 20 mA, V _{CC} = 5.0V, D = .050" (5,7)
QRD1114	I _{C(ON)}	1.0		5.0	mA	I _F = 20 mA, V _{CC} = 5.0V, D = .050" (5,7)
Crosstalk	I _{CX}	—	200	—	nA	I _F = 20 mA, V _{CC} = 5.0V, E _e = 0(6)
Saturation Voltage	V _{CE(SAT)}	—		0.40	V	I _F = 40 mA, I _C = 100μA, D = .050" (5,7)

NOTES

1. Derate power dissipation linearly 1.33 mW/ $^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Soldering iron $\frac{1}{16}''$ (1.6mm) from housing.
4. As long as leads are not under any stress or spring tension.
5. D is the distance from the sensor face to the reflective surface.
6. Crosstalk (I_{CX}) is the collector current measured with the indicated current on the input diode and with no reflective surface.
7. Measured using Eastman Kodak neutral white test card with 90% diffused reflecting as a reflecting surface.

QRD1313

PACKAGE DIMENSIONS



ST2173

DESCRIPTION

The QRD1313 reflective sensors consists of an infrared emitting diode and an NPN silicon photodarlington mounted side by side in a black plastic housing. The on-axis radiation of the emitter and the on-axis response of the detector are both perpendicular to the face of the QRD1313. The photodarlington responds to radiation emitted from the diode only when a reflective object or surface is in the field of view of the detector.

FEATURES

- Photodarlington output.
- Unfocused for sensing diffused surfaces.
- Low cost plastic housing.
- Designed for paper path and other non-contact surface sensing.

NOTES:

1. PINS 2 AND 4 TYPICALLY .050" SHORTER THAN PINS 1 AND 3
2. DIMENSIONS ARE IN INCHES (mm).
3. TOLERANCE IS $\pm .010$ [.25] UNLESS OTHERWISE SPECIFIED.
4. THESE DIMENSIONS ARE CONTROLLED AT HOUSING SURFACE.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 100°C
Operating Temperature	-40°C to + 100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,4)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	15 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

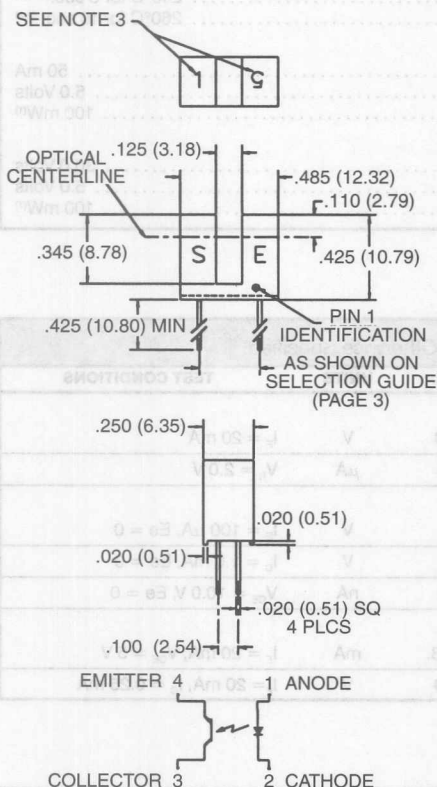
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V _F	—		1.70	V	I _F = 20 mA
Reverse Leakage Current	I _R	—		100	μA	V _R = 2.0 V
OUTPUT DARLINGTON						
Collector-Emitter Breakdown	BV _{CEO}	15.0		—	V	I _C = 100 μA, E _e = 0
Emitter-Collector Breakdown	BV _{CE0}	5.0		—	V	I _E = 100 μA, E _e = 0
Collector-Emitter Leakage	I _{CEO}	—		250	nA	V _{CE} = 5.0 V, E _e = 0
COUPLED						
On-State Collector Current	I _{C(ON)}	10.0		—	mA	I _F = 20 mA, V _{CC} = 5.0V, D = .050" ^(5,7)
Crosstalk	I _{CX}	—		10	μA	I _F = 20 mA, V _{CC} = 5.0V, E _e = 0 ⁽⁶⁾
Saturation Voltage	V _{CE(SAT)}	—		1.10	V	I _F = 20 mA, I _C = 2mA, D = .050" ^(5,7)

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C.
2. RMA flux is recommended.
3. Soldering iron 1/16" (1.6mm) minimum from housing.
4. As long as leads are not under any stress or spring tension.
5. D is the distance from the sensor face to the reflective surface.
6. Crosstalk (I_{CX}) is the collector current measured with the indicated current on the input diode and with no reflective surface.
7. Measured using Eastman Kodak neutral white test card with 90% diffused reflecting as a reflecting surface.

PACKAGE DIMENSIONS



DESCRIPTION

The QVA series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust and dirt buildup while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Ambient light and dust protection.
- Lead spacing available at .220", .300", or .320".
- .010" and .050" apertures.

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5 = .050", 1 = .010")

ST2174

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0\text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	See selection guide page 3.			mA	$I_F = 20\text{ mA}$, $V_{CE} = 5\text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 20\text{ mA}$, $I_C = 0.25\text{ mA}$

NOTES

1. Derate power dissipation linearly $1.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}"$ (1.6 mm) from housing.

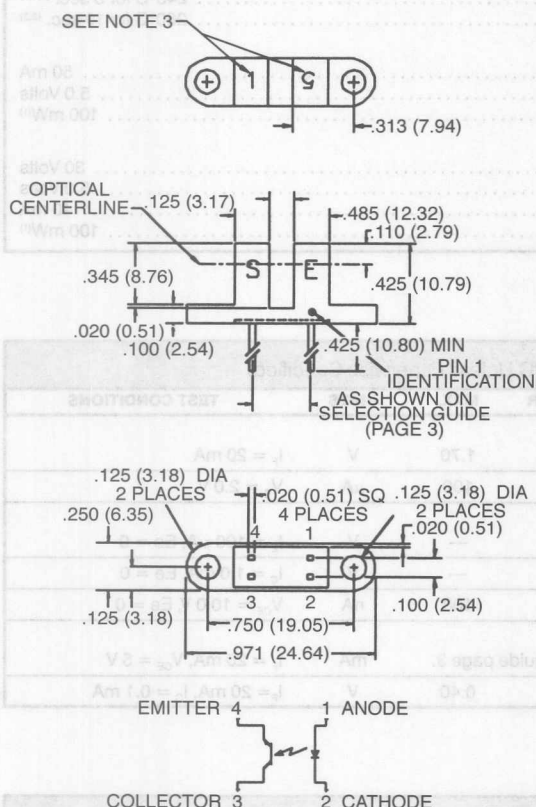
QVAXXXX OPTICAL SWITCH SELECTION GUIDE

PART NUMBER	LEAD SPACING	APERTURES		I _{C(ON)}	
		LED	SENSOR	MIN	MAX
QVA11123	.220"	0.050"	0.010"	0.20	—
QVA11124	.220"	0.050"	0.010"	0.50	—
QVA11223	.300"	0.050"	0.010"	0.20	—
QVA11224	.300"	0.050"	0.010"	0.50	—
QVA11323	.320"	0.050"	0.010"	0.20	—
QVA11324	.320"	0.050"	0.010"	0.50	—
QVA11133	.220"	0.050"	0.050"	0.50	—
QVA11134	.220"	0.050"	0.050"	1.00	—
QVA11233	.300"	0.050"	0.050"	0.50	—
QVA11234	.300"	0.050"	0.050"	1.00	—
QVA11333	.320"	0.050"	0.050"	0.50	—
QVA11334	.320"	0.050"	0.050"	1.00	—
QVA21113	.220"	0.010"	0.010"	0.10	—
QVA21114	.220"	0.010"	0.010"	0.20	—
QVA21213	.300"	0.010"	0.010"	0.10	—
QVA21214	.300"	0.010"	0.010"	0.20	—
QVA21313	.320"	0.010"	0.010"	0.10	—
QVA21314	.320"	0.010"	0.010"	0.20	—

SPECIFICATIONS FOR OVAL SHAFTS					
PART NUMBER	LEAD SPACING	LEAD	APERTURE	TOLERANCE	
				MIN	MAX
QVA1134	350"	0.010"	0.010"	0.00	—
QVA1134	350"	0.080"	0.010"	0.00	—
QVA1133	300"	0.080"	0.010"	0.00	—
QVA1134	300"	0.080"	0.010"	0.00	—
QVA1133	350"	0.080"	0.010"	0.00	—
QVA1134	350"	0.080"	0.010"	0.00	—
QVA1133	350"	0.080"	0.020"	0.00	—
QVA1134	350"	0.080"	0.080"	1.00	—
QVA1133	300"	0.080"	0.080"	0.00	—
QVA1134	300"	0.080"	0.080"	1.00	—
QVA1133	350"	0.080"	0.080"	0.00	—
QVA1134	350"	0.080"	0.080"	1.00	—
QVA1133	350"	0.010"	0.010"	0.10	—
QVA1134	350"	0.010"	0.010"	0.50	—
QVA1133	300"	0.010"	0.010"	0.10	—
QVA1134	300"	0.010"	0.010"	0.50	—
QVA1133	350"	0.010"	0.010"	0.10	—
QVA1134	350"	0.010"	0.010"	0.50	—

QVB SERIES

PACKAGE DIMENSIONS



DESCRIPTION

The QVB series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust and dirt buildup while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Ambient light and dust protection.
- Lead spacing available at .220", .300", or .320".
- .050" and .010" apertures available.

ST2175

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5 = .050", 1 = .010")

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	40 mA
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F	—	1.70	—	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	—	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5	—	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	—	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	See selection guide page 3.			mA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	—	V	$I_F = 20 \text{ mA}$, $I_C = 0.1 \text{ mA}$

NOTES

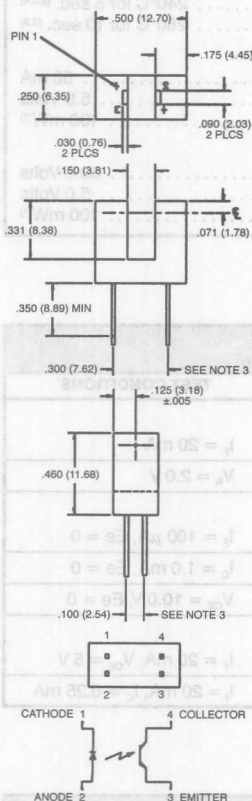
1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) from housing.

QVBXXXX OPTICAL SWITCH SELECTION GUIDE

PART NUMBER	LEAD SPACING	APERTURES		I _{C(ON)}	
		LED	SENSOR	MIN	MAX
QVB11123	.220"	0.050"	0.010"	0.20	—
QVB11124	.220"	0.050"	0.010"	0.50	—
QVB11223	.300"	0.050"	0.010"	0.20	—
QVB11224	.300"	0.050"	0.010"	0.50	—
QVB11323	.320"	0.050"	0.010"	0.20	—
QVB11324	.320"	0.050"	0.010"	0.50	—
QVB11133	.220"	0.050"	0.050"	0.50	—
QVB11134	.220"	0.050"	0.050"	1.00	—
QVB11233	.300"	0.050"	0.050"	0.50	—
QVB11234	.300"	0.050"	0.050"	1.00	—
QVB11333	.320"	0.050"	0.050"	0.50	—
QVB11334	.320"	0.050"	0.050"	1.00	—
QVB21113	.220"	0.010"	0.010"	0.10	—
QVB21114	.220"	0.010"	0.010"	0.20	—
QVB21213	.300"	0.010"	0.010"	0.10	—
QVB21214	.300"	0.010"	0.010"	0.20	—
QVB21313	.320"	0.010"	0.010"	0.10	—
QVB21314	.320"	0.010"	0.010"	0.20	—

SPECIFICATIONS					
PART NUMBER	LEAD SPACING	LEAD	SENSOR	MIN	MAX
QV81133	.350"	0.050"	0.010"	0.50	—
QV81134	.350"	0.050"	0.010"	0.50	—
QV81133	.300"	0.050"	0.010"	0.50	—
QV81134	.300"	0.050"	0.010"	0.50	—
QV81133	.350"	0.050"	0.010"	0.50	—
QV81134	.350"	0.050"	0.010"	0.50	—
QV81133	.350"	0.050"	0.050"	0.50	—
QV81134	.350"	0.050"	0.050"	1.00	—
QV81133	.300"	0.050"	0.050"	0.50	—
QV81134	.300"	0.050"	0.050"	1.00	—
QV81133	.350"	0.050"	0.050"	0.50	—
QV81134	.350"	0.050"	0.050"	1.00	—
QV81113	.350"	0.010"	0.010"	0.10	—
QV81114	.350"	0.010"	0.010"	0.50	—
QV81113	.300"	0.010"	0.010"	0.10	—
QV81114	.300"	0.010"	0.010"	0.50	—
QV81113	.350"	0.010"	0.010"	0.10	—
QV81114	.350"	0.010"	0.010"	0.50	—

PACKAGE DIMENSIONS



DESCRIPTION

The QVE11233 is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .150" (3.81 mm) gap.

FEATURES

- Lead spacing .300".
- Gap width of .150".
- Printed circuit board mounting.
- 2 mm aperture width.

ST2176

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. THIS DIMENSION IS CONTROLLED AT THE HOUSING SURFACE.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
INPUT DIODE					
Forward Voltage	V_f	—	1.70	—	V
Reverse Leakage Current	I_r	—	100	—	μA
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	—	V
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V
Collector-Emitter Leakage	I_{ECO}	—	100	—	nA
COUPLED					
On-State Collector Current	I_{ON}	0.30	—	—	Am
Saturation Voltage	$V_{CE(sat)}$	—	0.40	—	V

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

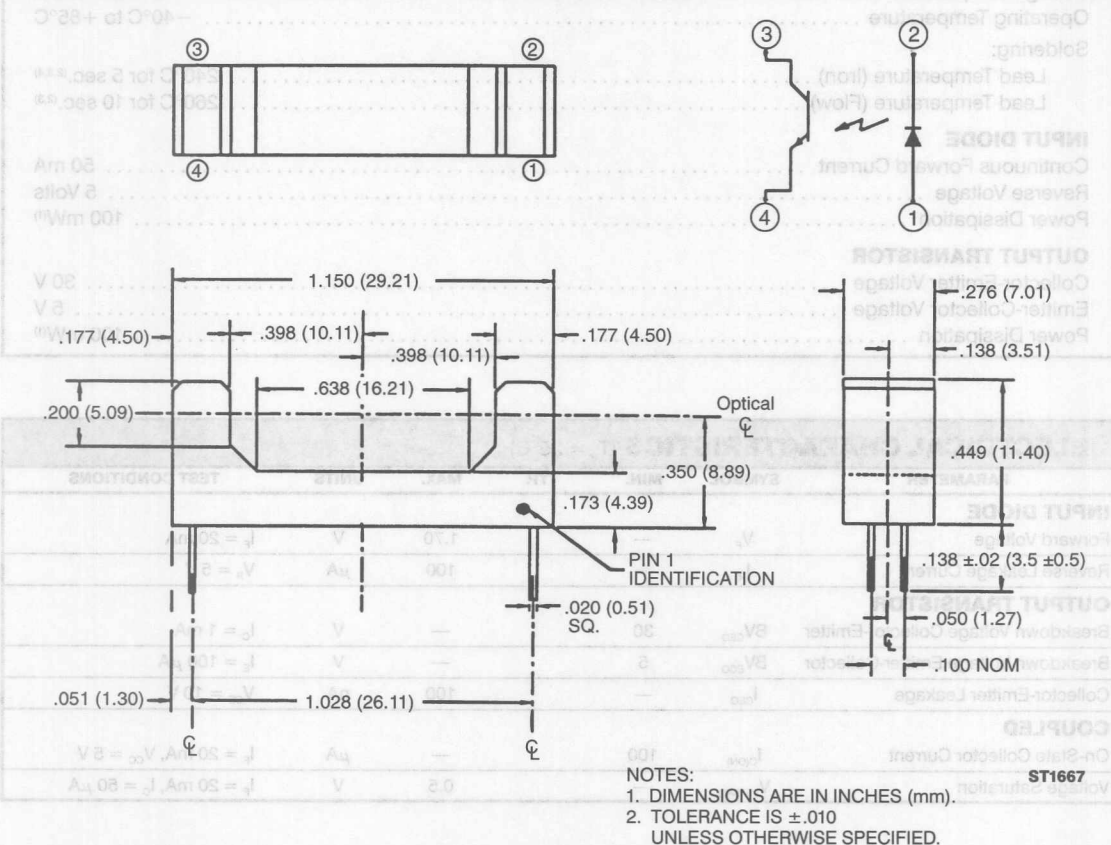
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F	—		1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0\text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	0.50		—	mA	$I_F = 20\text{ mA}$, $V_{CE} = 5\text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 20\text{ mA}$, $I_C = 0.25\text{ mA}$

NOTES

1. Derate power dissipation linearly $1.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

PACKAGE DIMENSIONS



DESCRIPTION

The QVL21653 consists of an infrared light emitting diode coupled to an NPN silicon phototransistor packaged into an injection molded housing. The housing is designed for wide gap, non contact sensing.

FEATURE

- 20mm wide gap
- PC Board mount
- .060" apertures
- Sensor filter to attenuate visible light

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to +85°C
Operating Temperature	-40°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 V
Emitter-Collector Voltage	5 V
Power Dissipation	100 mW ⁽¹⁾

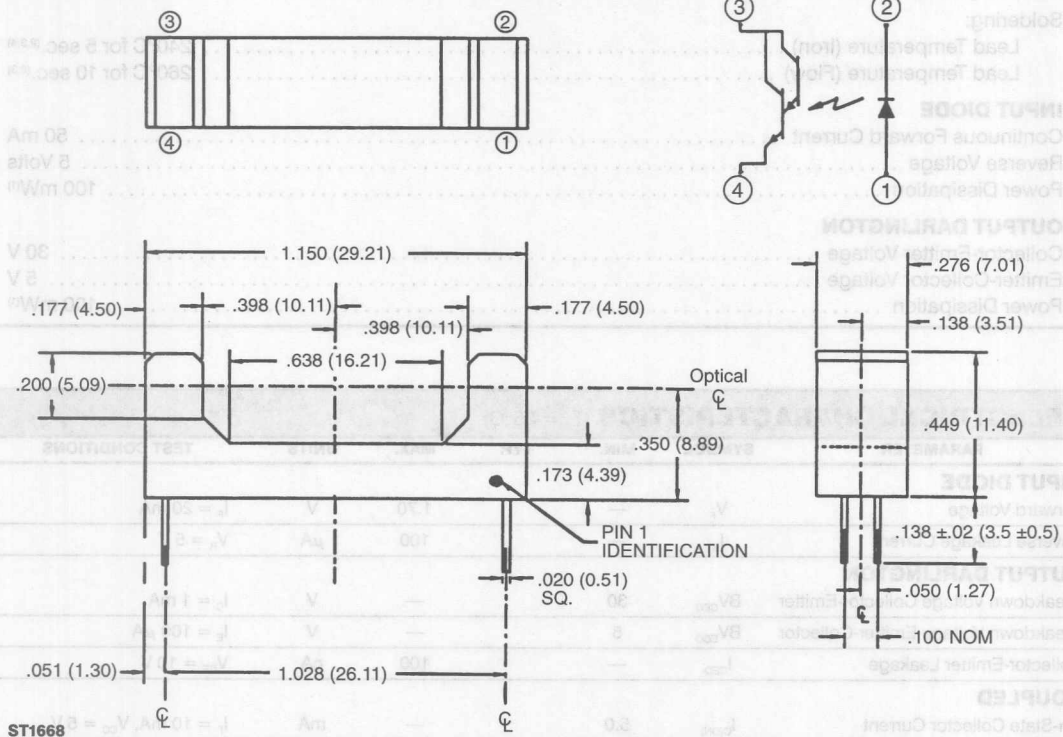
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 5 \text{ V}$
OUTPUT TRANSISTOR						
Breakdown Voltage Collector-Emitter	BV_{CEO}	30		—	V	$I_C = 1 \text{ mA}$
Breakdown Voltage Emitter-Collector	BV_{ECO}	5		—	V	$I_E = 100 \mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10 \text{ V}$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	100		—	μA	$I_F = 20 \text{ mA}, V_{CC} = 5 \text{ V}$
Voltage Saturation	$V_{CE(SAT)}$	—		0.5	V	$I_F = 20 \text{ mA}, I_C = 50 \mu\text{A}$

NOTES

1. Derate power dissipation linearly, on each component, 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) from housing.

PACKAGE DIMENSIONS



NOTES:

1. DIMENSIONS ARE IN INCHES [mm].
2. TOLERANCE IS $\pm .010$
UNLESS OTHERWISE SPECIFIED.

DESCRIPTION

The QVL25335 consists of an infrared light emitting diode coupled to an NPN silicon photodarlington packaged into an injection molded housing.

FEATURE

- 20 mm wide gap
- PC Board mount
- .060" apertures
- Sensor filter to attenuate visible light
- High CTR

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	30 V
Emitter-Collector Voltage	5 V
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 5\text{ V}$
OUTPUT DARLINGTON						
Breakdown Voltage Collector-Emitter	BV_{CEO}	30		—	V	$I_C = 1\text{ mA}$
Breakdown Voltage Emitter-Collector	BV_{ECO}	5		—	V	$I_E = 100\text{ }\mu\text{A}$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10\text{ V}$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	5.0		—	mA	$I_F = 10\text{ mA}$, $V_{CC} = 5\text{ V}$
Voltage Saturation	$V_{CE(SAT)}$	—		1.0	V	$I_F = 10\text{ mA}$, $I_C = 2\text{ mA}$

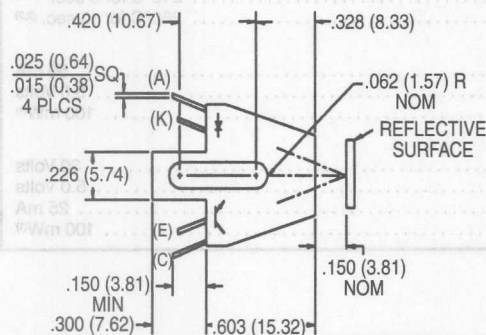
NOTES

1. Derate power dissipation linearly, on each component, $1.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB703/OPB704/OPB705

3

PACKAGE DIMENSIONS

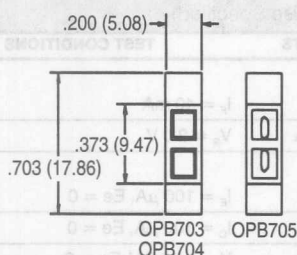


DESCRIPTION

The OPB703, OPB704, and OPB705 consist of an infrared emitting diode and an NPN silicon phototransistor mounted side by side on a converging optical axis in a black plastic housing. The phototransistor responds to radiation from the emitting diode only when a reflective object passes within its field of view. The area of the optimum response approximates a circle .200" in diameter.

FEATURES

- Phototransistor output.
- High Sensitivity.
- Low cost plastic housing.
- OPB703/OPB704, dust cover; lens.
- OPB705, offset lens.



- (C) COLLECTOR
(E) EMITTER
(K) CATHODE
(A) ANODE

ST2154

NOTES:

1. CATHODE AND EMITTER LEADS ARE .050" NOM SHORTER THAN ANODE AND COLLECTOR LEADS.
2. DIMENSIONS ARE IN INCHES (mm).
3. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

OPB703 - IR TRANSPARENT DUST COVER
OPB704 - IR TRANSPARENT DUST COVER
OPB705 - OFFSET LENS

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	25 mA
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

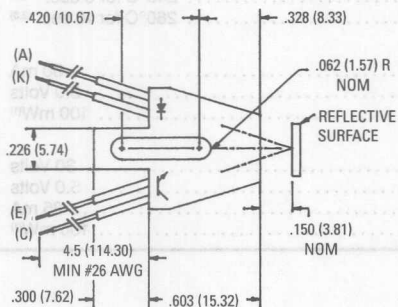
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 40\text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0\text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB703	$I_{C(ON)}$	200		μA	$I_F = 40\text{ mA}$, $V_{CE} = 5\text{ V}$, $D = .150''$ ^(5,6)
OPB704	$I_{C(ON)}$	200		μA	$I_F = 40\text{ mA}$, $V_{CE} = 5\text{ V}$, $D = .150''$ ^(5,6)
OPB705	$I_{C(ON)}$	100		μA	$I_F = 40\text{ mA}$, $V_{CE} = 5\text{ V}$, $D = .150''$ ^(5,6)
Crosstalk	I_{CX}	—	20	μA	$I_F = 40\text{ mA}$, $V_{CE} = 5\text{ V}$ ⁽⁷⁾

NOTES

1. Derate power dissipation linearly $1.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $1/16''$ (1.6 mm) from housing.
5. D is the distance from the assembly face to the reflective surface.
6. Measured using Eastman Kodak neutral test card with 90% diffused reflecting surface.
7. Cross talk is the photocurrent measured with current to the input diode and no reflective surface.

OPB703W/OPB704W/OPB705W

PACKAGE DIMENSIONS



DESCRIPTION

The OPB703W, OPB704W, and OPB705W consist of an infrared emitting diode and an NPN silicon phototransistor mounted side by side on a converging optical axis in a black plastic housing. The phototransistor responds to radiation from the emitting diode only when a reflective object passes within its field of view. The area of the optimum response approximates a circle .200" in diameter. Leads are 26 AWG, PVC insulation, 4.5" (114.3 mm) minimum length, stripped and tinned.

FEATURES

- Phototransistor output.
- High Sensitivity.
- Low cost plastic housing.
- Pre wired with 4.5 inch, 26 gauge leads.
- OPB703W/OPB704W, dust cover; lens.
- OPB705W, offset lens.

FUNCTION	WIRE COLOR	UNIT	MAX.	MIN.
(C) COLLECTOR	WHITE	V	1.0	0.5
(E) EMITTER	BLUE	V	1.0	0.5
(K) CATHODE	GREEN	A	100	10
(A) ANODE	ORANGE	A	100	10
NOTES				
1. DIMENSIONS ARE IN INCHES (mm).				
2. TOLERANCE IS ±.010 (.25)				
OPB703W - IR TRANSPARENT DUST COVER				
OPB704W - IR TRANSPARENT DUST COVER				
OPB705W - OFFSET LENS				

ST4018

3

OPB703W/OPB704W/OPB705W

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Collector Current	25 mA
Power Dissipation	100 mW ⁽¹⁾

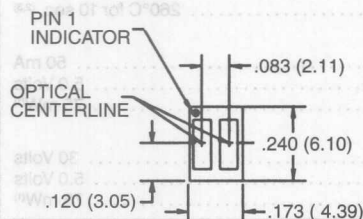
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 40 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB703W	$I_{C(ON)}$	200	—	μA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,6)
OPB704W	$I_{C(ON)}$	200	—	μA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,6)
OPB705W	$I_{C(ON)}$	100	—	μA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$, $D = .150''$ ^(5,6)
Crosstalk	I_{CX}	—	20	μA	$I_F = 40 \text{ mA}$, $V_{CE} = 5 \text{ V}$ ⁽⁷⁾

NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}''$ (1.6 mm) from housing.
- D is the distance from the assembly face to the reflective surface.
- Measured using Eastman Kodak neutral test card with 90% diffused reflecting surface.
- Cross talk is the photocurrent measured with current to the input diode and no reflective surface.

PACKAGE DIMENSIONS

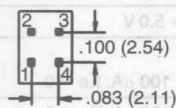
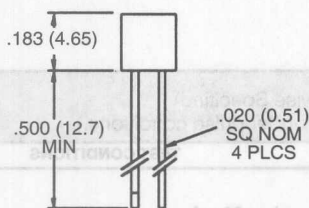


DESCRIPTION

The OPB706A/B/C reflective sensors consist of an infrared emitting diode and an NPN silicon phototransistor mounted side by side in a black plastic housing. The on-axis radiation of the emitter and the on-axis response of the detector are both perpendicular to the face of the OPB706A/B/C. The phototransistor responds to radiation emitted from the diode only when a reflective object or surface is in the field of view of the detector.

FEATURES

- Phototransistor output.
- Unfocused for sensing diffused surfaces.
- Low cost plastic housing.
- Designed for paper path and other non-contact surface sensing.



- NOTES:
1. PINS 2 AND 4 ARE TYPICALLY .050" SHORTER THAN PINS 1 AND 3.
 2. DIMENSIONS ARE IN INCHES (mm).
 3. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	75 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	75 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYPE.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward voltage	V_F	—		1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 5.0 \text{ V}$
OUTPUT TRANSISTOR						
Collector-Emitter Breakdown	BV_{ECO}	30		—	V	$I_C = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	5		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
OPB706A	$I_{C(ON)}$	500		—	μA	$I_F = 20 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$, $D = .050''$ ^(5,7)
OPB706B	$I_{C(ON)}$	350		—	μA	$I_F = 20 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$, $D = .050''$ ^(5,7)
OPB706C	$I_{C(ON)}$	200		—	μA	$I_F = 20 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$, $D = .050''$ ^(5,7)
Crosstalk	I_{CX}	—	200	—	nA	$I_F = 20 \text{ mA}$, $V_{CC} = 5.0 \text{ V}$, $E_e = 0$ ⁽⁶⁾
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 40 \text{ mA}$, $I_C = 100 \mu\text{A}$, $D = .050''$ ^(5,7)

NOTES

- Derate power dissipation linearly 1.25 mW/°C above 25°C.
- RMA flux is recommended.
- Soldering iron tip $\frac{1}{16}''$ (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- D is the distance from the sensor face to the reflective surface.
- Crosstalk (I_{CX}) is the collector current measured with the indicated current on the input diode and with no reflective surface.
- Measured using Eastman Kodak neutral white test card with 90% diffused reflectance as a reflecting surface.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYPE	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0\text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	500		—	μA	$I_F = 20\text{ mA}$, $V_{CE} = 5\text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 20\text{ mA}$, $I_C = 0.25\text{ mA}$

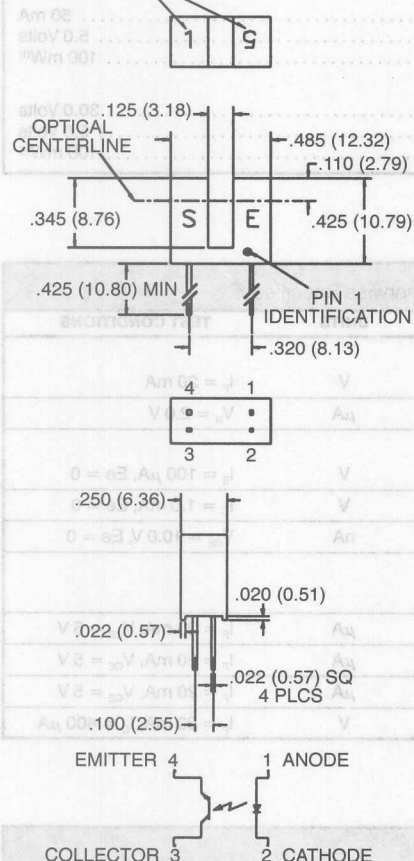
NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) from housing.



PACKAGE DIMENSIONS

SEE NOTE 3



DESCRIPTION

The OPB860N series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .320".
- .050" and .010" aperture options.
- PCB mountable.

ST2158

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE. (5 = .050", 1 = .010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB860N11	.010	.010
OPB860N51	.050	.010
OPB860N55	.050	.050

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. (2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

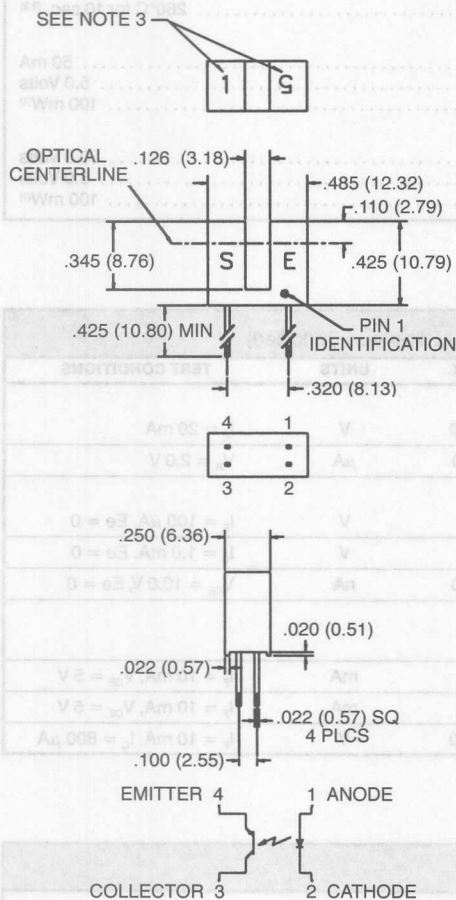
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB860N11	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB860N51	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB860N55	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	V	$I_F = 20 \text{ mA}$, $I_C = 400 \mu\text{A}$

NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB861N51/OPB861N55

PACKAGE DIMENSIONS



ST2159

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE. (5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB861N51	.050	.010
OPB861N55	.050	.050

DESCRIPTION

The OPB861N series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .320".
- .050" and .010" aperture options.
- PCB mountable.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to $+85^\circ\text{C}$
Operating Temperature	-40°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

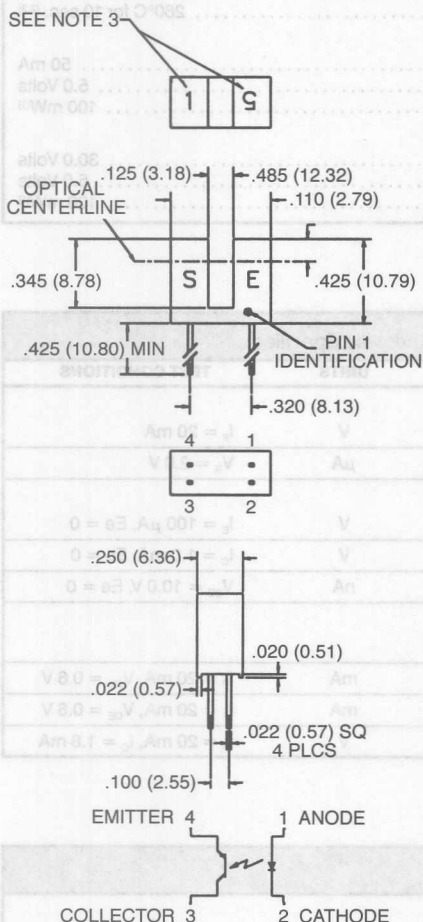
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20\text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0\text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0\text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB861N51	$I_{C(ON)}$	1.0	—	mA	$I_F = 10\text{ mA}$, $V_{CE} = 5\text{ V}$
OPB861N55	$I_{C(ON)}$	1.0	—	mA	$I_F = 10\text{ mA}$, $V_{CE} = 5\text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	V	$I_F = 10\text{ mA}$, $I_C = 800\text{ }\mu\text{A}$

NOTES

1. Derate power dissipation linearly $1.67\text{ mW}/^\circ\text{C}$ above 25°C .
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB862N51/OPB862N55

PACKAGE DIMENSIONS



DESCRIPTION

The OPB862N series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .320".
- .050" and .010" aperture options.
- PCB mountable.

ST2161

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB862N51	.050	.010
OPB862N55	.050	.050

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

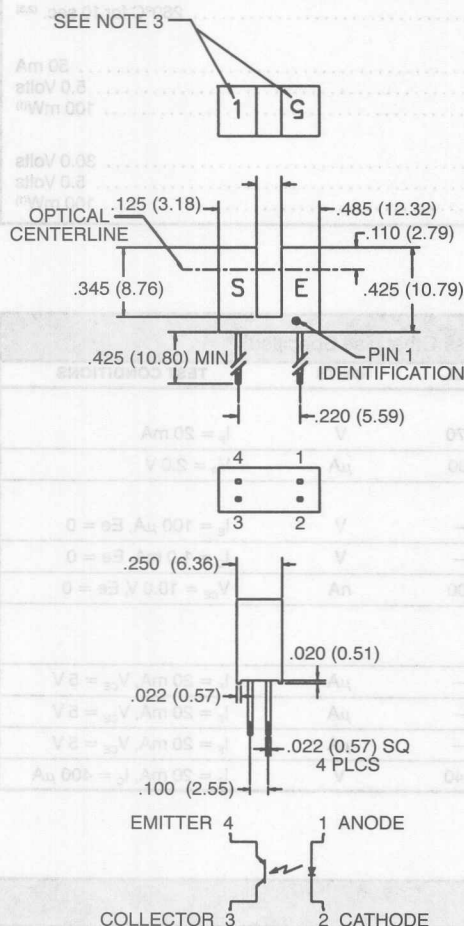
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB862N51	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
OPB862N55	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.60	V	$I_F = 20 \text{ mA}$, $I_C = 1.8 \text{ mA}$

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB865N11/OPB865N51/OPB865N55

PACKAGE DIMENSIONS



DESCRIPTION

The OPB865N series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .220".
- .050" and .010" aperture options.
- PCB mountable.

ST2163

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB865N11	.010	.010
OPB865N51	.050	.010
OPB865N55	.050	.050

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

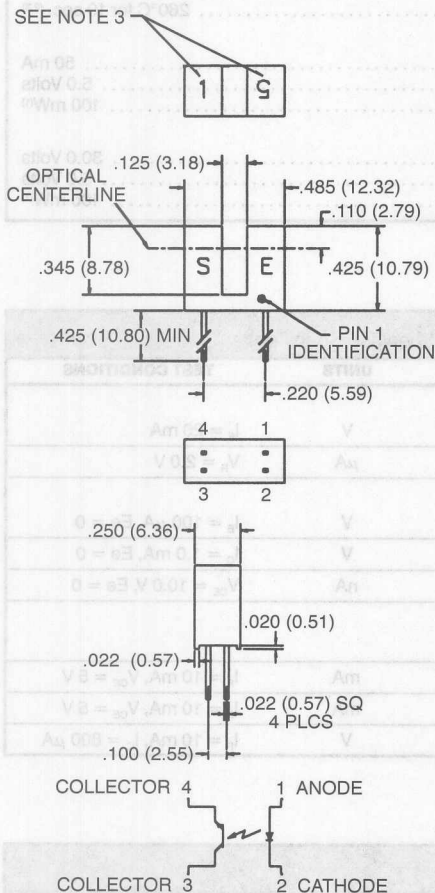
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB865N11	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB865N51	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB865N55	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	V	$I_F = 20 \text{ mA}$, $I_C = 400 \mu\text{A}$

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB866N51/OPB866N55

PACKAGE DIMENSIONS



DESCRIPTION

The OPB866N series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .220".
- .050" and .010" aperture options.
- PCB mountable.

ST2165

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5 = .050", 1 = .010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB866N51	.050	.010
OPB866N55	.050	.050

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Unless Otherwise Specified)

Storage Temperature	−40°C to + 85°C
Operating Temperature	−40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. (2,3)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

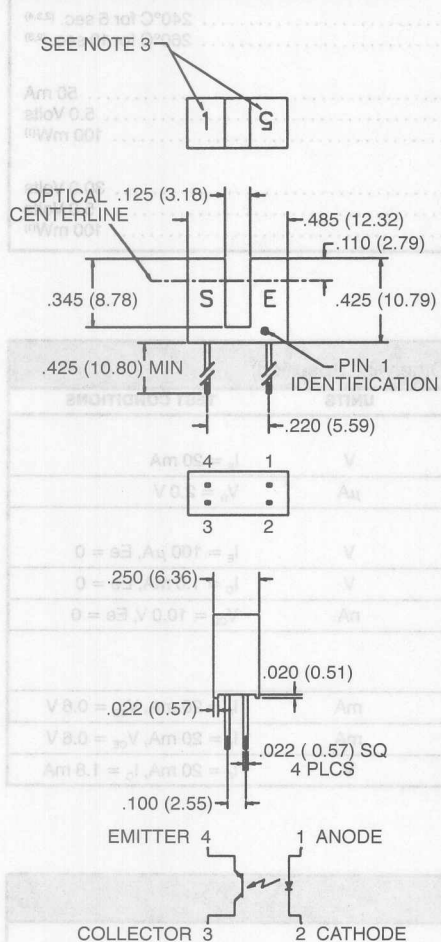
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V _F	—	1.70	V	I _F = 20 mA
Reverse Leakage Current	I _R	—	100	μA	V _R = 2.0 V
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV _{ECO}	5	—	V	I _E = 100 μA, Ee = 0
Collector-Emitter Breakdown	BV _{CEO}	30	—	V	I _C = 1.0 mA, Ee = 0
Collector-Emitter Leakage	I _{CEO}	—	100	nA	V _{CE} = 10.0 V, Ee = 0
COUPLED					
On-State Collector Current					
OPB866N51	I _{C(ON)}	1.0	—	mA	I _F = 10 mA, V _{CE} = 5 V
OPB866N55	I _{C(ON)}	1.0	—	mA	I _F = 10 mA, V _{CE} = 5 V
Saturation Voltage	V _{CE(SAT)}	—	0.40	V	I _F = 10 mA, I _C = 800 μA

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) from housing.

OPB867N51/OPB867N55

PACKAGE DIMENSIONS



ST2167

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB867N51	.050	.010
OPB867N55	.050	.050

DESCRIPTION

The OPB867N series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .220".
- .050" and .010" aperture options.
- PCB mountable.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

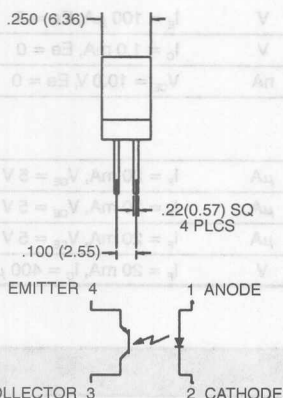
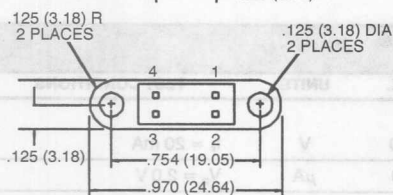
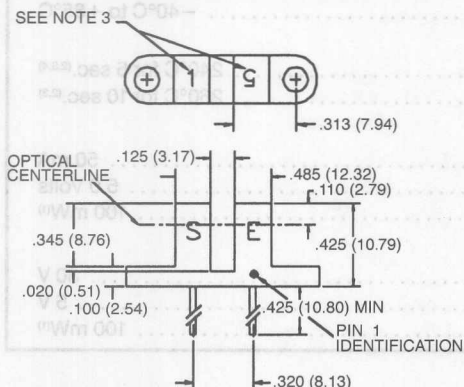
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB867N51	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
OPB867N55	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.60	V	$I_F = 20 \text{ mA}$, $I_C = 1.8 \text{ mA}$

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB860T11/OPB860T51/OPB860T55

PACKAGE DIMENSIONS



ST1782

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OP8860T11	.010	.010
OP8860T51	.050	.010
OP8860T55	.050	.050

DESCRIPTION

The OPB860T series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust protection.
- Lead spacing at .320".
- .050" and .010" aperture options.
- PCB mountable.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to +85°C
Operating Temperature	-40°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)
INPUT DIODE	
Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾
OUTPUT TRANSISTOR	
Collector-Emitter Voltage	30 V
Emitter-Collector Voltage	5 V
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

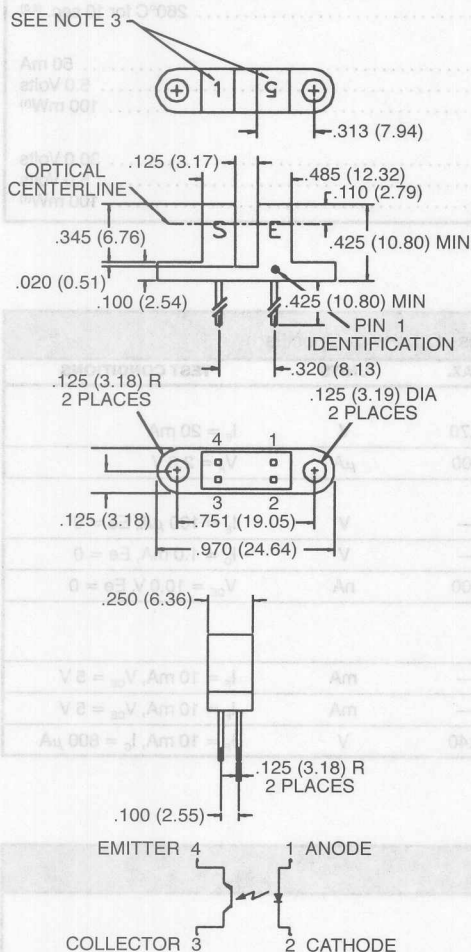
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current						
OPB860T11	$I_{C(ON)}$	500		—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB860T51	$I_{C(ON)}$	500		—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB860T55	$I_{C(ON)}$	500		—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 20 \text{ mA}$, $I_C = 400 \mu\text{A}$

NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB861T51/OPB861T55

PACKAGE DIMENSIONS



ST2160

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE. (5 = .050", 1 = .010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB861T51	.050	.010
OPB861T55	.050	.050

DESCRIPTION

The OPB861T series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .320".
- .050" and .010" aperture options.
- PCB mountable.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. (2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB861T51	$I_{C(ON)}$	1.0	—	mA	$I_F = 10 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB861T55	$I_{C(ON)}$	1.0	—	mA	$I_F = 10 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	V	$I_F = 10 \text{ mA}$, $I_C = 800 \mu\text{A}$

NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB862T51	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
OPB862T55	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.60	V	$I_F = 20 \text{ mA}$, $I_C = 1.8 \text{ mA}$

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

OPB865T11/OPB865T51/OPB865T55

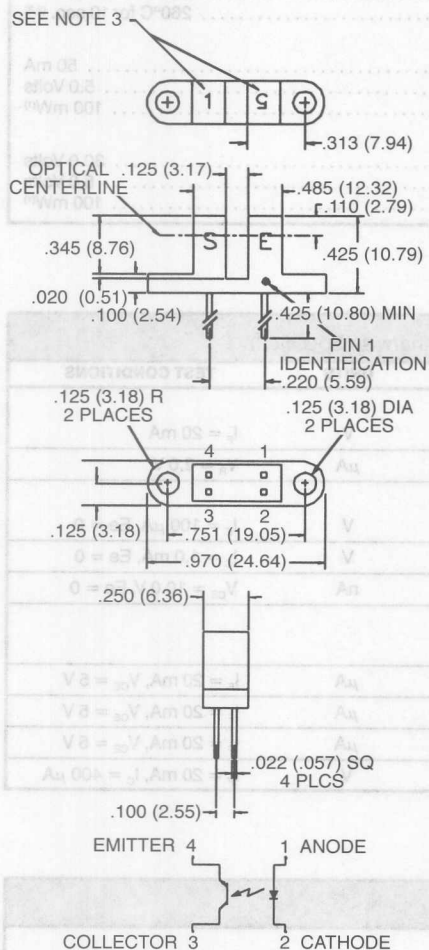
PACKAGE DIMENSIONS

DESCRIPTION

The OPB8651 series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .220".
- .050" and .010" aperture options.
- PCB mountable.



ST2164

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25)
UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB865T11	.010	.010
OPB865T51	.050	.010
OPB865T55	.050	.050

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to + 85°C
Operating Temperature	-40°C to + 85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB865T11	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB865T51	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB865T55	$I_{C(ON)}$	500	—	μA	$I_F = 20 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	V	$I_F = 20 \text{ mA}$, $I_C = 400 \mu\text{A}$

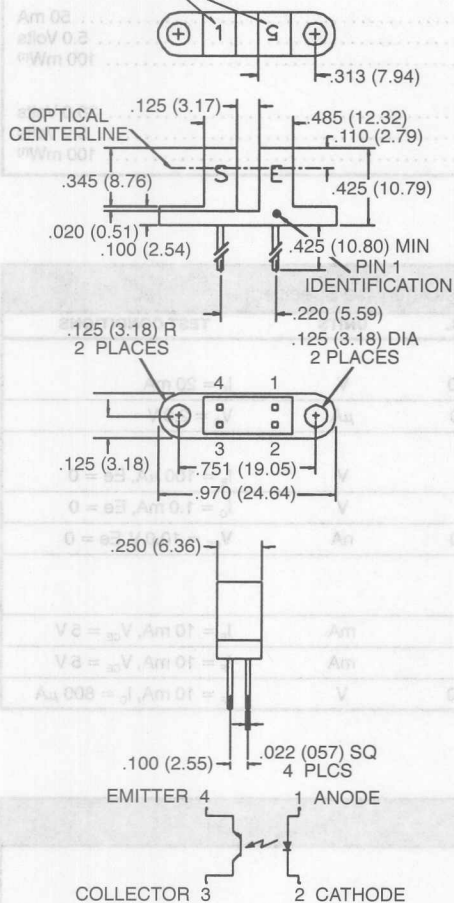
NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

PACKAGE DIMENSIONS

DESCRIPTION

SEE NOTE 3



ST2166

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25)
UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE.
(5=.050", 1=.010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB866T51	.050	.010
OPB866T55	.050	.050

The OPB866T series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .220".
- .050" and .010" aperture options.
- PCB mountable.

The drawing shows the mechanical specifications of the OPB6815 optoisolator. The top view is a rectangular package with a central square window. Dimensions include a total width of .970 (24.64), a central window width of .751 (19.05), and a pin pitch of .250 (6.36). There are two mounting holes on each side, with a diameter of .125 (3.18) and a distance of .220 (5.59) from the edge. The side view shows a package height of .125 (3.18) and a mounting tab width of .125 (3.18).

Top View Dimensions:

- Pin Pitch: .250 (6.36)
- Mounting Hole Diameter: .125 (3.18)
- Mounting Hole Spacing: .220 (5.59)
- Central Window Width: .751 (19.05)
- Total Package Width: .970 (24.64)

Side View Dimensions:

- Package Height: .125 (3.18)
- Mounting Tab Width: .125 (3.18)

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to +85°C
Operating Temperature	-40°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

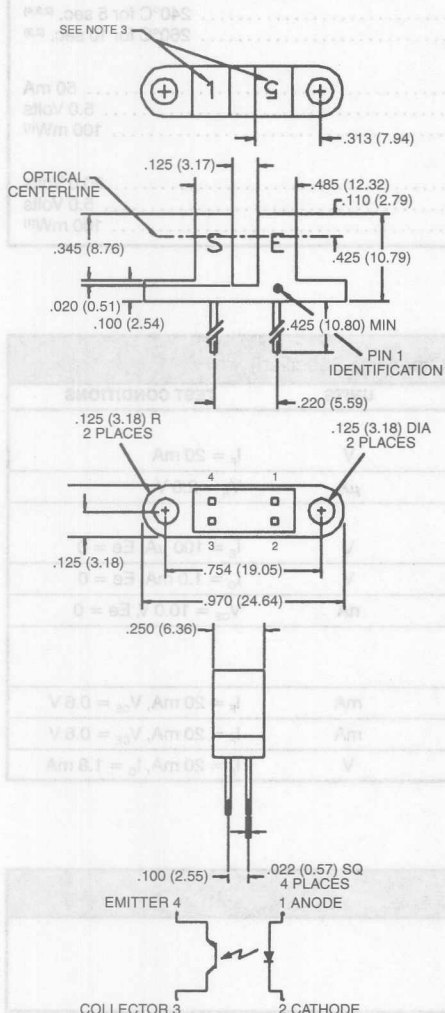
PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB866T51	$I_{C(ON)}$	1.0	—	mA	$I_F = 10 \text{ mA}$, $V_{CE} = 5 \text{ V}$
OPB866T55	$I_{C(ON)}$	1.0	—	mA	$I_F = 10 \text{ mA}$, $V_{CE} = 5 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.40	V	$I_F = 10 \text{ mA}$, $I_C = 800 \mu\text{A}$

NOTES

- Derate power dissipation linearly 1.67 mW/°C above 25°C.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip 1/16" (1.6 mm) from housing.

OPB867T51/OPB867T55

PACKAGE DIMENSIONS



ST2127

NOTES:

1. DIMENSIONS ARE IN INCHES (mm).
2. TOLERANCE IS $\pm .010$ (.25) UNLESS OTHERWISE SPECIFIED.
3. NUMBER INDICATES APERTURE SIZE. (5 = .050", 1 = .010")

APERTURE OPTIONS:

	LED	PHOTOTRANSISTOR
OPB867T51	.050	.010
OPB867T55	.050	.050

DESCRIPTION

The OPB867T series of switches is designed to allow the user maximum flexibility in applications. Each switch consists of an infrared emitting diode facing an NPN phototransistor across a .125" (3.18 mm) gap. A unique housing design provides a smooth external surface to prevent dust build-up while molded internal apertures give precise positioning and also provide protection from ambient light interference.

FEATURES

- Fully enclosed design allows dust and ambient light protection.
- Lead spacing at .220".
- .050" and .010" aperture options.
- PCB mountable.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-40°C to +85°C
Operating Temperature	-40°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3)

INPUT DIODE

Continuous Forward Current	50 mA
Reverse Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30.0 Volts
Emitter-Collector Voltage	5.0 Volts
Power Dissipation	100 mW ⁽¹⁾

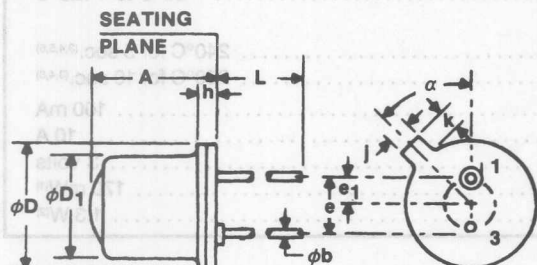
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE					
Forward Voltage	V_F	—	1.70	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	100	μA	$V_R = 2.0 \text{ V}$
OUTPUT TRANSISTOR					
Emitter-Collector Breakdown	BV_{ECO}	5	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	V	$I_C = 1.0 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	nA	$V_{CE} = 10.0 \text{ V}$, $E_e = 0$
COUPLED					
On-State Collector Current					
OPB867T51	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
OPB867T55	$I_{C(ON)}$	1.8	—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 0.6 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—	0.60	V	$I_F = 20 \text{ mA}$, $I_C = 1.8 \text{ mA}$

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) from housing.

PACKAGE DIMENSIONS



ST1332

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.255		6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi D1	.180	.188	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e1	.050 NOM.		1.27 NOM.		2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
alpha	45°	45°	45°	45°	3

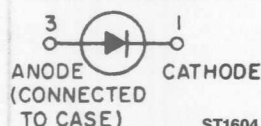
DESCRIPTION

The 1N6264 is a 940nm LED in a narrow angle, TO-46 package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level
- (*) indicates JEDEC registered values

PACKAGE OUTLINE



NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

*Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
*Soldering:	
*Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
*Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
*Continuous Forward Current	100 mA
*Forward Current (pw, 1μS; 200 Hz)	10 A
*Reverse Voltage	3 Volts
*Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
*Forward Voltage	V_F	—		1.7	V	$I_F = 100 \text{ mA}$
*Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
*Peak Emission Wavelength	λ_p	935		955	nm	$I_F = 100 \text{ mA}$
Emission Angle at 1/2 Power	θ		±8		Degrees	
*Total Power	P_o	6		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r		1.0		μS	
Fall Time 100-10% of output	t_f		1.0		μS	

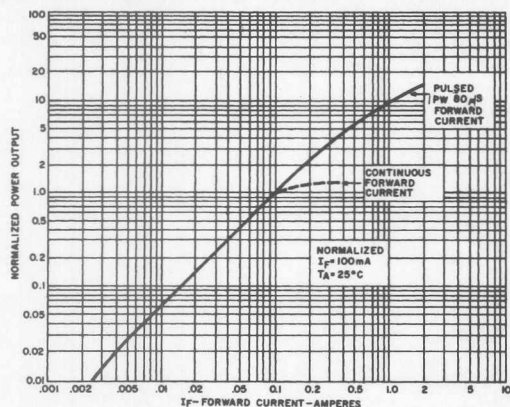
NOTES

1. Derate power dissipation linearly 1.70 mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_o , is the total power radiated by the device into a solid angle of 2π steradians.

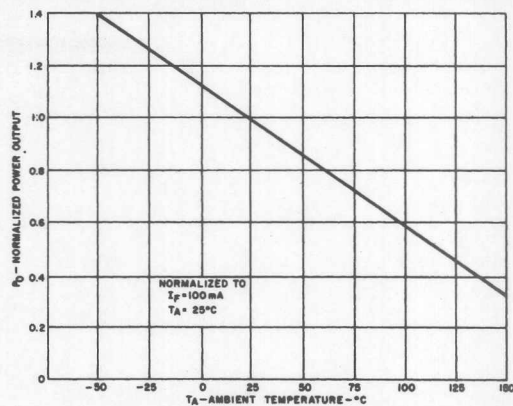


NOTES:
1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER 0.021" (0.53mm).
MEASURED IN GAUGING PLANE 0.04" ± 0.01" - 0.00"
(0.13 + 0.08 - 0.00mm) BELOW THE REFERENCE
PLANE OF THE DEVICE SHALL BE WITHIN 0.03"
(0.76mm) THEIR TRUE POSITION RELATIVE TO A
MAXIMUM WIDTH TAB.
3. FROM CENTRAL LINE TAB.

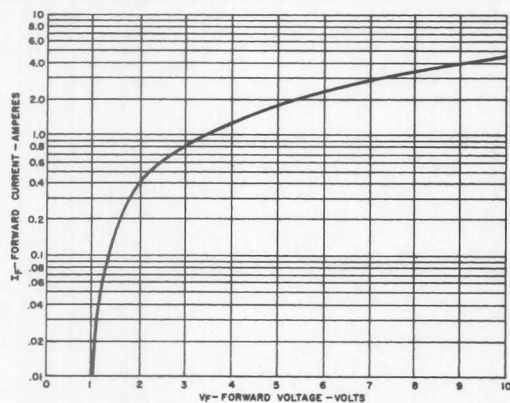
TYPICAL CHARACTERISTICS



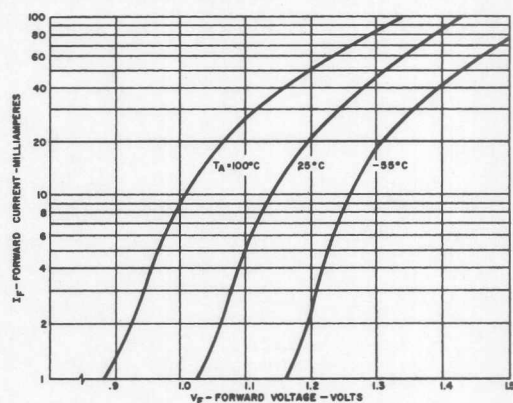
ST1002



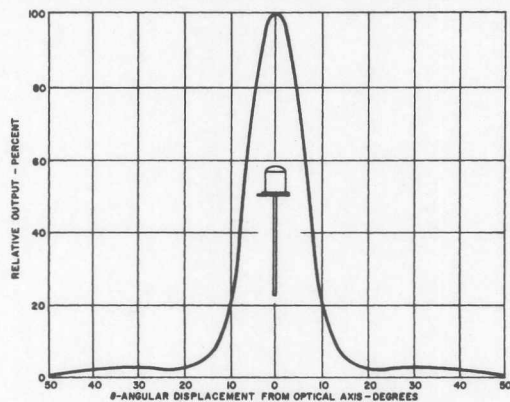
ST1007



ST1003



ST1006



ST1004

TYPICAL CHARACTERISTICS

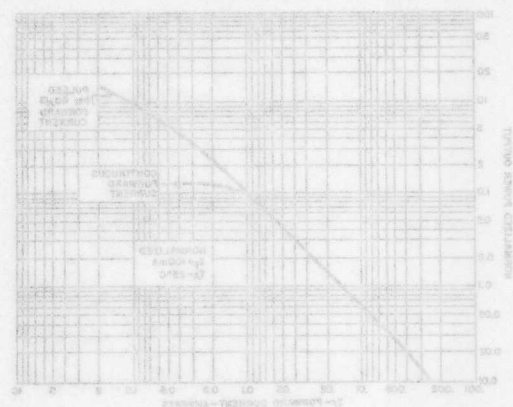


Fig. 1. Power Output vs. Input Current ST1005

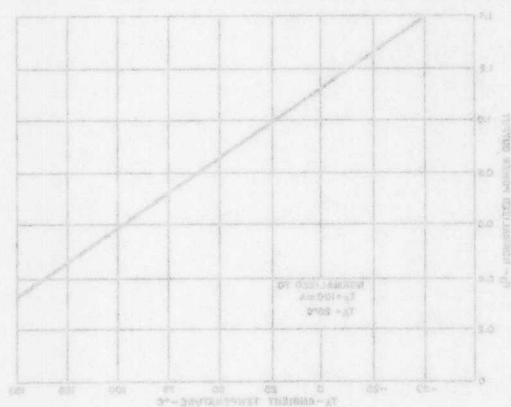


Fig. 2. Power Output vs. Temperature ST1007

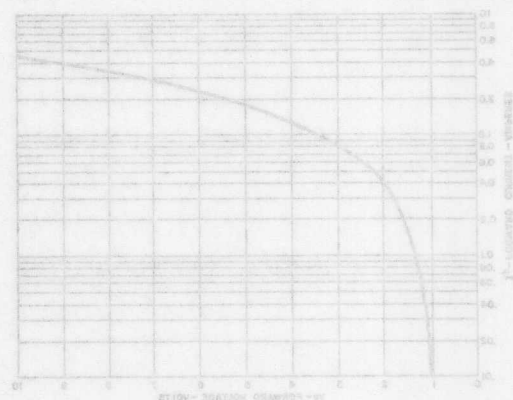


Fig. 3. Forward Voltage vs. Forward Current ST1006

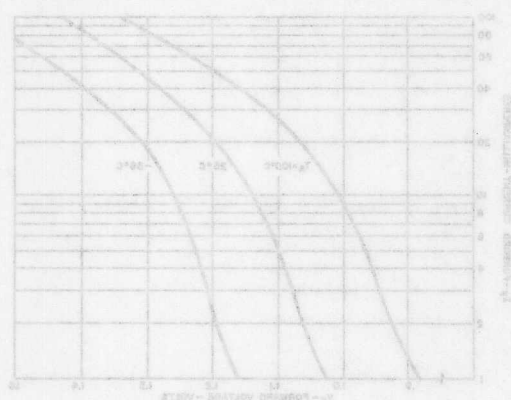


Fig. 4. Forward Voltage vs. Forward Current ST1006

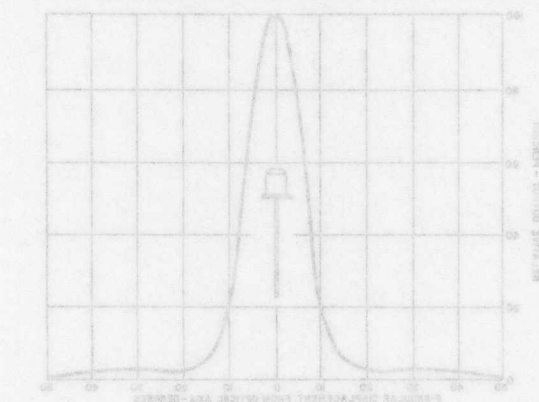
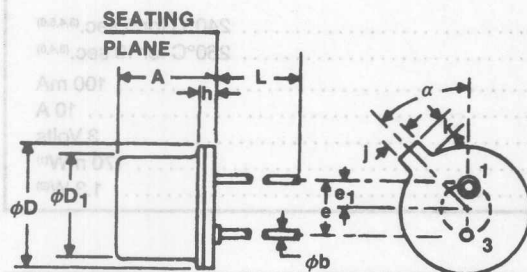


Fig. 5. 118324 - Typical Radiation Pattern ST1004

PACKAGE DIMENSIONS



DESCRIPTION

The 1N6265 is a 940nm LED in a wide angle, TO-46 package.

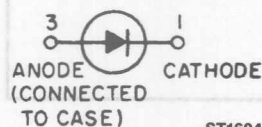
FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level
- (*) indicates JEDEC registered values

ST1331

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.155		3.93	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi D1	.180	.187	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e1	.050 NOM.		1.27 NOM.		2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
alpha	45°	45°	45°	45°	3

PACKAGE OUTLINE



ST1604

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

*Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
*Soldering:	
*Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
*Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
*Continuous Forward Current	100 mA
*Forward Current (pw, 1μS; 200 Hz)	10 A
*Reverse Voltage	3 Volts
*Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
*Forward Voltage	V_F	—	—	1.7	V	$I_F = 100 \text{ mA}$
*Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 3 \text{ V}$
*Peak Emission Wavelength	λ_p	935	—	955	nm	$I_F = 100 \text{ mA}$
Emission Angle at ½ Power	θ	—	±40	—	Degrees	
*Total Power	P_o	6	—	—	mW	$I_F = 100 \text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r	—	1.0	—	μS	
Fall Time 100-10% of output	t_f	—	1.0	—	μS	

NOTES

1. Derate power dissipation linearly 1.70 mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_o , is the total power radiated by the device into a solid angle of 2π steradians.



TYPICAL CHARACTERISTICS

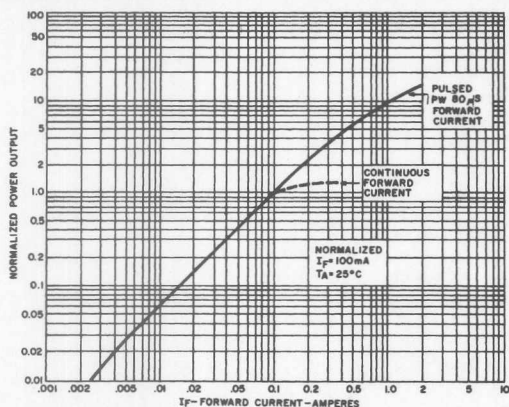


Fig. 1. Power Output vs. Input Current ST1002

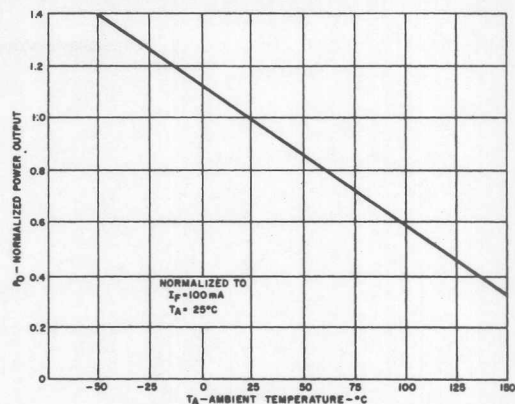


Fig. 2. Power Output vs. Temperature ST1007

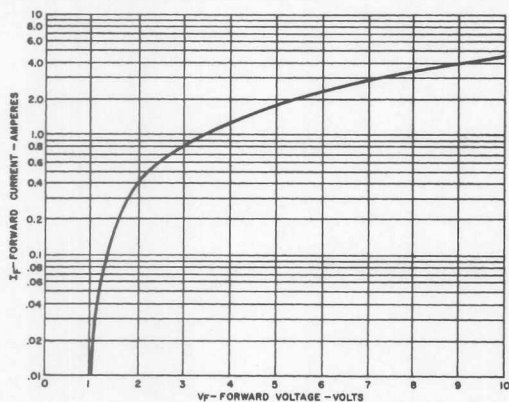


Fig. 3. Forward Voltage vs. Forward Current ST1003

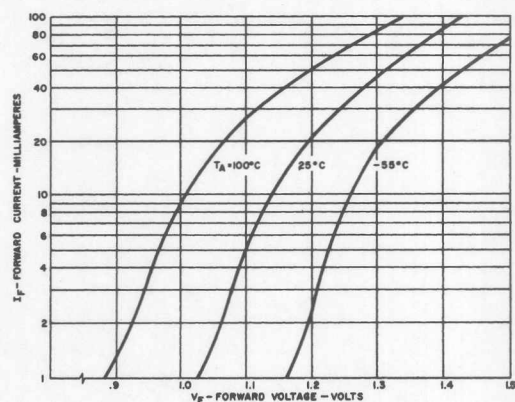


Fig. 4. Forward Voltage vs. Forward Current ST1006

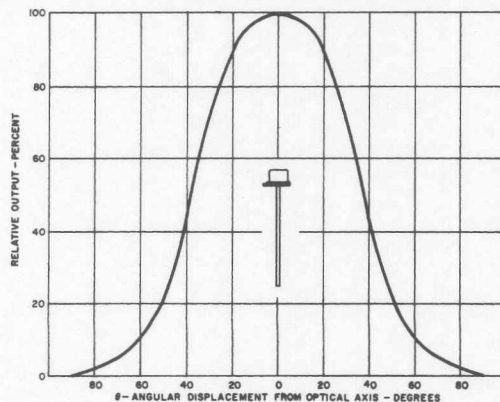


Fig. 6. 1N6265 — Typical Radiation Pattern ST1005

3

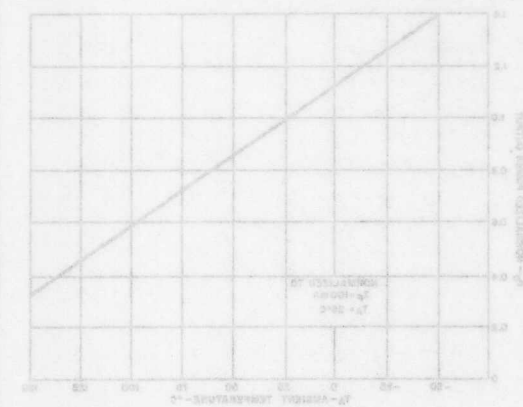


Fig. 2. Power Output vs. Temperature

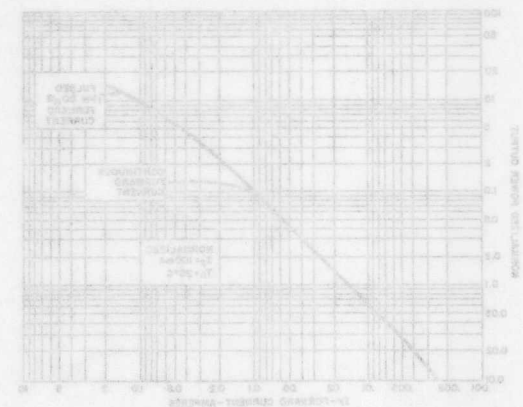


Fig. 1. Power Output vs. Input Current

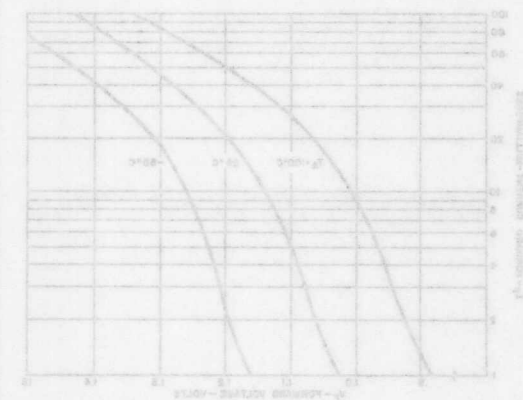


Fig. 4. Forward Voltage vs. Forward Current

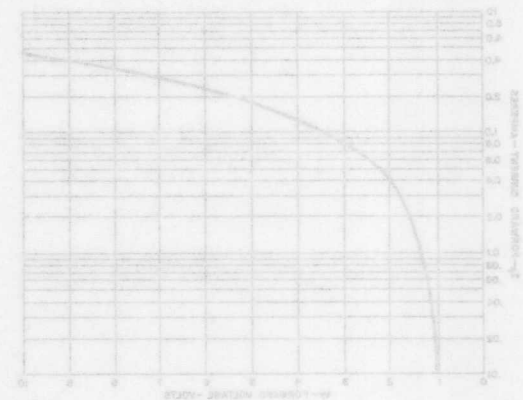


Fig. 3. Forward Voltage vs. Forward Current

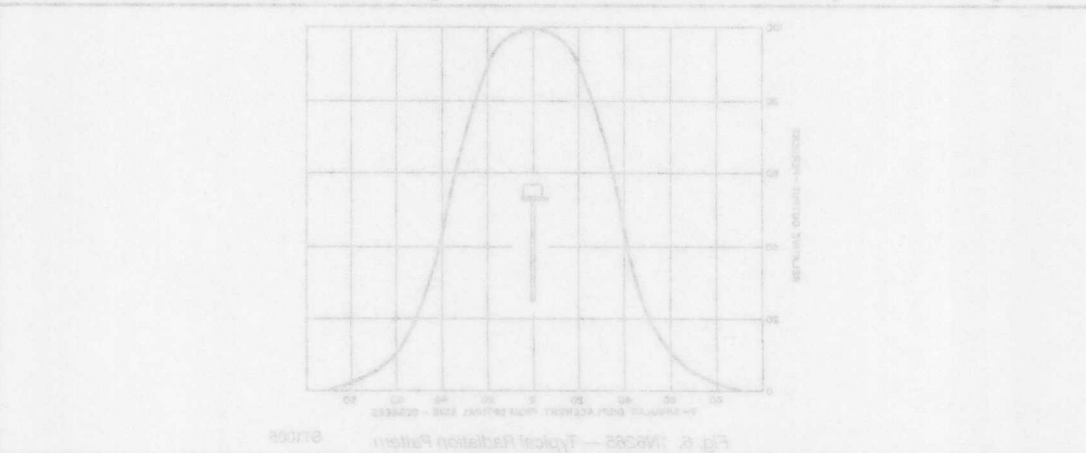
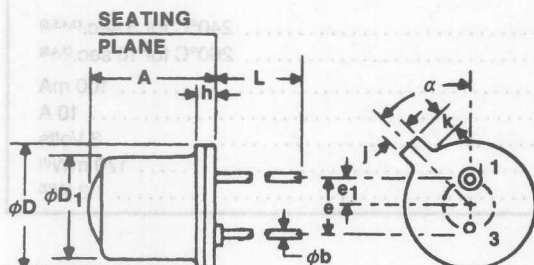


Fig. 5. Typical Radiation Pattern

PACKAGE DIMENSIONS



ST1332

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.255		6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi D1	.180	.188	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e1	.050 NOM.		1.27 NOM.		2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
alpha	45°	45°	45°	45°	3

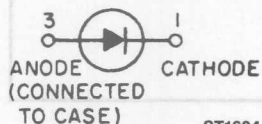
DESCRIPTION

The 1N6266 is a 940nm LED in a narrow angle, TO-46 package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level
- (*) indicates JEDEC registered values

PACKAGE OUTLINE



ST1604

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

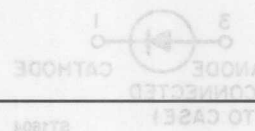
*Storage Temperature		-65°C to $+150^\circ\text{C}$
Operating Temperature		-65°C to $+125^\circ\text{C}$
*Soldering:		
*Lead Temperature (Iron)		240°C for 5 sec. ^(3,4,5,6)
*Lead Temperature (Flow)		260°C for 10 sec. ^(3,4,6)
*Continuous Forward Current		100 mA
*Forward Current (pw, $1\mu\text{S}$; 200 Hz)		10 A
*Reverse Voltage		3 Volts
*Power Dissipation ($T_A = 25^\circ\text{C}$)		170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)		1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.7	V	$I_F = 100\text{ mA}$
*Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 3\text{ V}$
*Peak Emission Wavelength	λ_p	935	—	955	nm	$I_F = 100\text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ	—	± 10	—	Degrees	
*Radiant Intensity	I_e	25	—	—	mW/sr	$I_F = 100\text{ mA}$
Rise Time 0-90% of output	t_r	—	1.0	—	μS	
Fall Time 100-10% of output	t_f	—	1.0	—	μS	

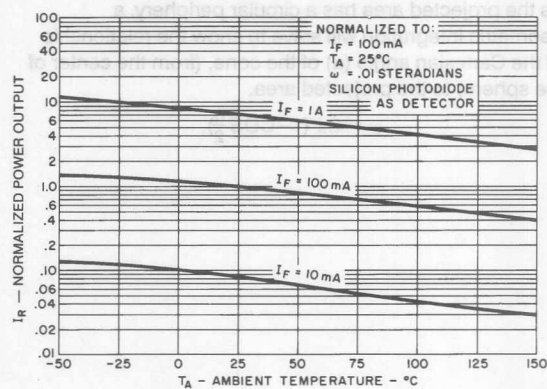
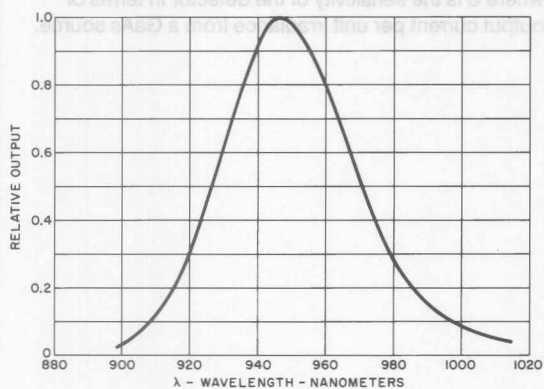
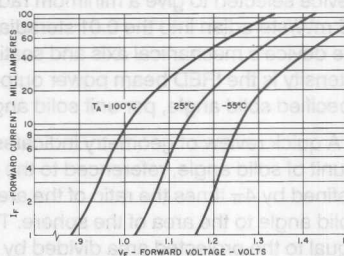
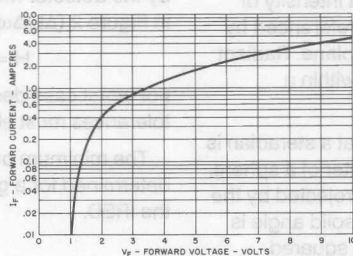
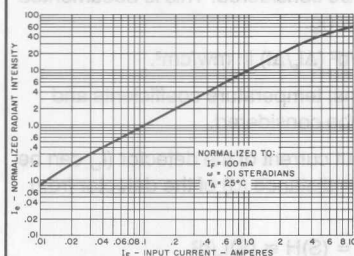
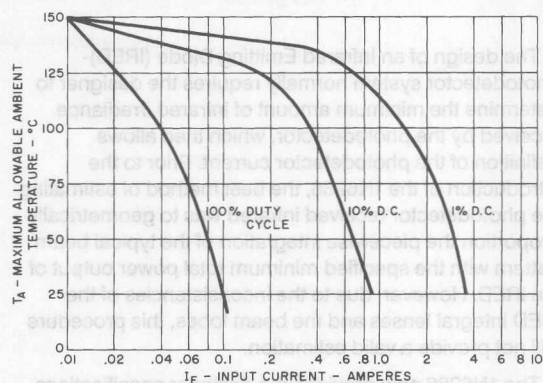
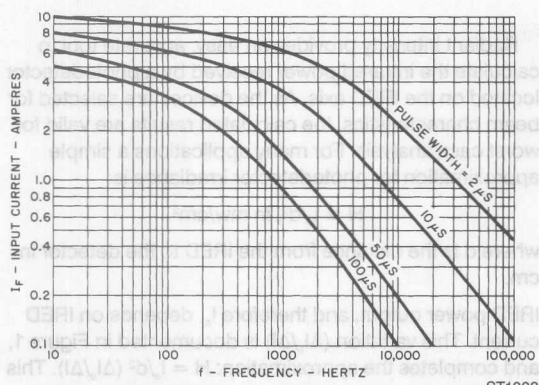
NOTES

1. Derate power dissipation linearly $1.70\text{ mW}/^\circ\text{C}$ above 25°C ambient.
2. Derate power dissipation linearly $13.0\text{ mW}/^\circ\text{C}$ above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.



NOTES:
1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER .021" (.53mm)
MEASURED IN GAUGING PLANE .004" + .001" - .000"
(.137 + .028 - .000mm) BELOW THE REFERENCE
PLANE OF THE DEVICE SHALL BE WITHIN .007"
(.178mm) THEIR TRUE POSITION RELATIVE TO A
MAXIMUM WIDTH TAB
3. FROM CENTRINE TAB

MAXIMUM RATING CURVES



INFRARED EMITTING DIODE RADIANT INTENSITY

The design of an Infrared Emitting Diode (IRED)-photodetector system normally requires the designer to determine the minimum amount of infrared irradiance received by the photodetector, which then allows definition of the photodetector current. Prior to the introduction of the 1N6266, the best method of estimating the photodetector received infrared was to geometrically proportion the piecewise integration of the typical beam pattern with the specified minimum total power output of the IRED. However, due to the inconsistencies of the IRED integral lenses and the beam lobes, this procedure will not provide a valid estimation.

The 1N6266 now provides the designer specifications which precisely define the infrared beam along the device's mechanical axis. The 1N6266 is a premium device selected to give a minimum radiant intensity of 25 mW/steradian into the 0.01 steradians referenced by the device's mechanical axis and seating plane. Radiant intensity is the IRED beam power output, within a specified solid angle, per unit solid angle.

A quick review of geometry indicates that a steradian is a unit of solid angle, referenced to the center of a sphere, defined by 4π times the ratio of the area projected by the solid angle to the area of the sphere. The solid angle is equal to the projected area divided by the squared radius.

$$\text{Steradians} = 4\pi A/4\pi R^2 = A/R^2 = \omega.$$

As the projected area has a circular periphery, a geometric integration will solve to show the relationship of the Cartesian angle (α) of the cone, (from the center of the sphere) to the projected area.

$$\omega = 2\pi (1 - \cos \frac{\alpha}{2}).$$

Radiant intensity provides an easy, accurate tool to calculate the infrared power received by a photodetector located on the IRED axis. As the devices are selected for beam characteristics, the calculated results are valid for worst case analysis. For many applications a simple approximation for photodetector irradiance is:

$$H \cong I_e/d^2, \text{ in mw/cm}^2$$

where d is the distance from the IRED to the detector in cm.

IRED power output, and therefore I_e , depends on IRED current. This variation ($\Delta I_e/\Delta I$) is documented in Figure 1, and completes the approximation: $H = I_e/d^2 (\Delta I_e/\Delta I)$. This normally gives a conservative value of irradiance. For more accurate results, the effect of precise angle viewed by the detector must be considered. This is documented in Figure 2 ($\Delta I_e/\Delta \omega$) giving:

$$H = I_e/d^2 (\Delta I_e/\Delta I) \text{ in mw/cm}^2.$$

For worst case designs, temperature coefficients and tolerances must also be considered.

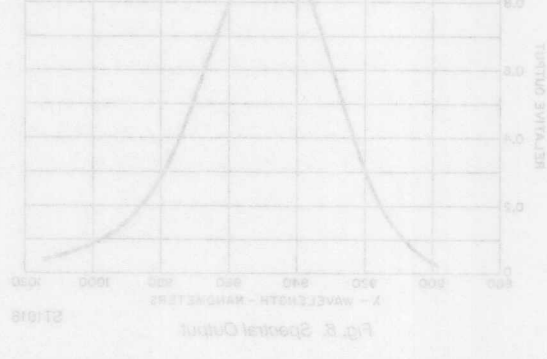
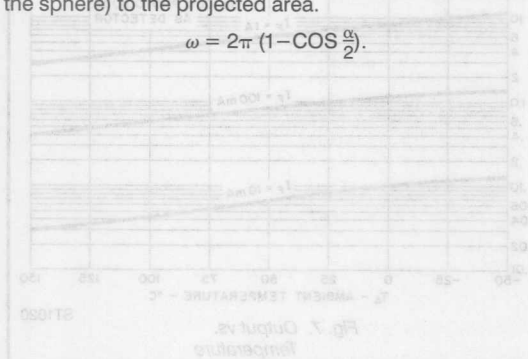
The minimum output current of the detector (I_L) can be determined for a given distance (d) of the detector from the IRED.

$$I_L = (S)H \cong (S)I_e/d^2$$

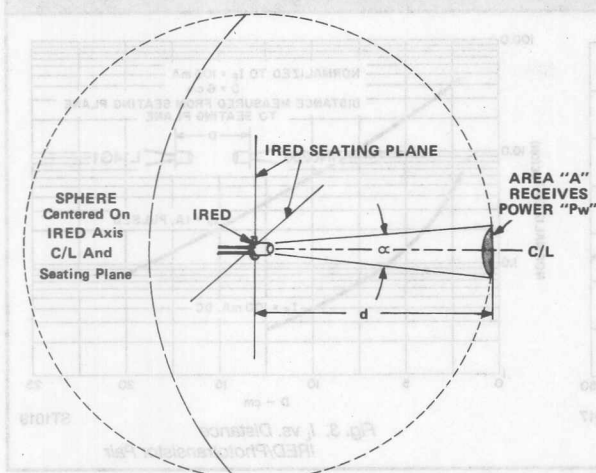
or

$$I_L = (S)H = (S) (I_e/d^2) (\Delta I_e/\Delta \omega) (\Delta I_e/\Delta I)$$

where S is the sensitivity of the detector in terms of output current per unit irradiance from a GaAs source.



IRED RADIANT INTENSITY SPECIFICATION CONCEPT



$$\omega = A/d^2 = 2\pi (1 - \cos \frac{\alpha}{2}) \text{ Steradians}$$

$$I_e = P_w/\omega \text{ mW/Steradian}$$

$$H = P_w/A = I_e/d^2 \text{ mW/cm}^2$$

MATCHING A PHOTOTRANSISTOR WITH 1N6266

Assume a system requiring a 10mA I_L at an IRED to detector spacing of 2cm (seating plane to seating plane), with bias conditions at specification points.

Given: $d_1 = 2 \text{ cm}$; $I_{L1} = 10 \text{ mA min.}$; $I_e = 25 \text{ mW/Steradian}$

Then: $H_1 \cong I_e/D_1^2 = 25/(2)^2 = 6.25 \text{ mW/cm}^2$.

Detector Evaluation:

TYPE	$I_L \text{ MIN. @ mA}$	$H \text{ (Tungsten) mw/cm}^2$	$H \text{ (GaAs) mw/cm}^2$	$S \text{ (GaAs) mA/mw/cm}^2$
L14G1	6	10	3	2
L14G2	3	10	3	1

Calculated $I_L = d_1$ is:

L14G1 (S) $H_1 = (2) 6.25 = 12.5 \text{ mA}$
 L14G2 (S) $H_1 = (1) 6.25 = 6.25 \text{ mA}$

Since the system requires an I_L of 10 mA minimum the correct device to use is the L14G1.

TYPICAL CHARACTERISTICS

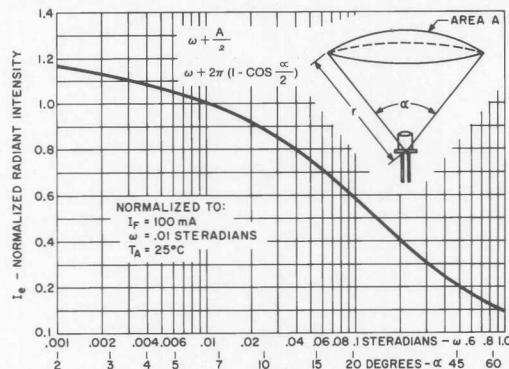


Fig. 1 Intensity and Power vs. Angle
 $\Delta I_e/\Delta \omega$

TYPICAL CHARACTERISTICS

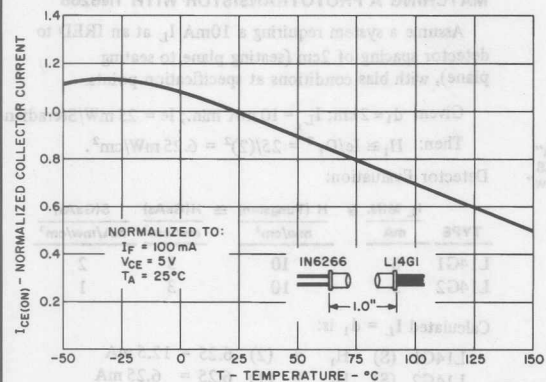


Fig. 2. Output vs. Temperature
 IRED/Phototransistor Pair

ST1017

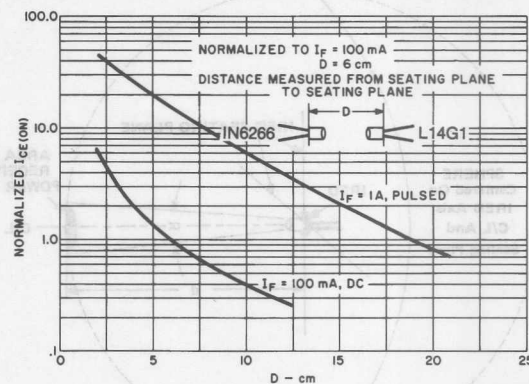
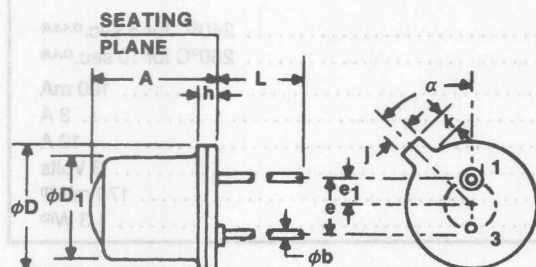


Fig. 3. I_c vs. Distance
 IRED/Phototransistor Pair

ST1019

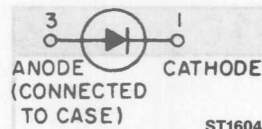
PACKAGE DIMENSIONS



ST11332

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	.255	—	6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi D1	.180	.188	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e1	.050 NOM.		1.27 NOM.		2
h	—	.030	—	.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00	—	25.4	—	
alpha	45°	45°	45°	45°	3

PACKAGE OUTLINE



NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

DESCRIPTION

The F5D series is 880nm LEDs in a narrow angle, TO-46 package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Continuous Forward Current	100 mA
Forward Current (pw, 10 μ S; 100 Hz)	3 A
Forward Current (pw, 1 μ S; 200 Hz)	10 A
Reverse Voltage	3 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 100$ mA
Reverse Leakage Current	I_R	—		10	μ A	$V_R = 3$ V
Peak Emission Wavelength	λ_p		880		nm	$I_F = 100$ mA
Emission Angle at 1/2 Power	θ		± 10		Degrees	
Total Power F5D1	P_o	12.0		—	mW	$I_F = 100$ mA ⁽⁷⁾
Total Power F5D2	P_o	9.0		—	mW	$I_F = 100$ mA ⁽⁷⁾
Total Power F5D3	P_o	10.5		—	mW	$I_F = 100$ mA ⁽⁷⁾
Rise Time 0-90% of output	t_r		1.5		μ S	
Fall Time 100-10% of output	t_f		1.5		μ S	

NOTES

1. Derate power dissipation linearly 1.70 mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_o , is the total power radiated by the device into a solid angle of 2π steradians.

TYPICAL CHARACTERISTICS

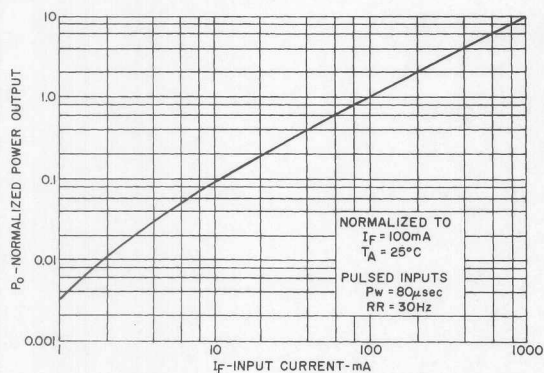


Fig. 1. Power Output vs. Input Current

ST1025

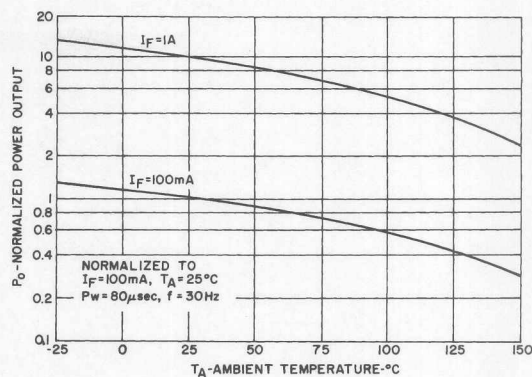


Fig. 2. Power Output vs. Temperature

ST1026

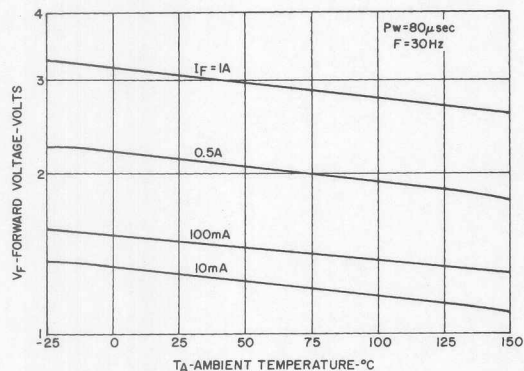


Fig. 3. Forward Voltage vs. Temperature

ST1027

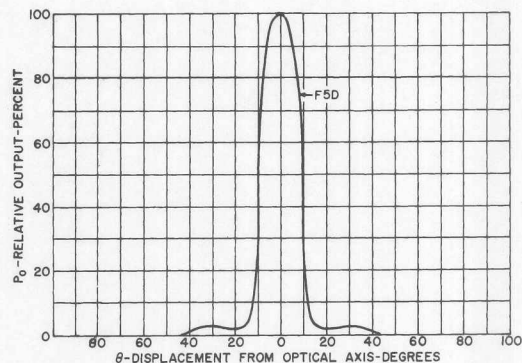


Fig. 4. Typical Radiation Pattern

ST1028-99

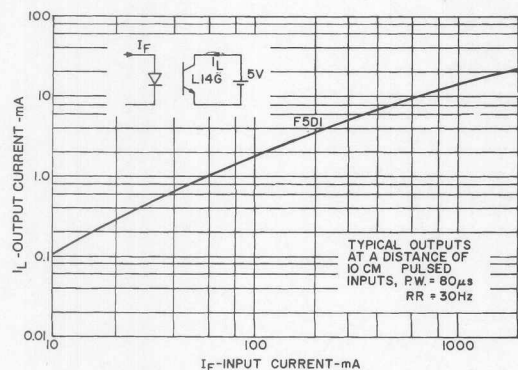


Fig. 5. Output vs. Input with L14G Detector

ST1029-99

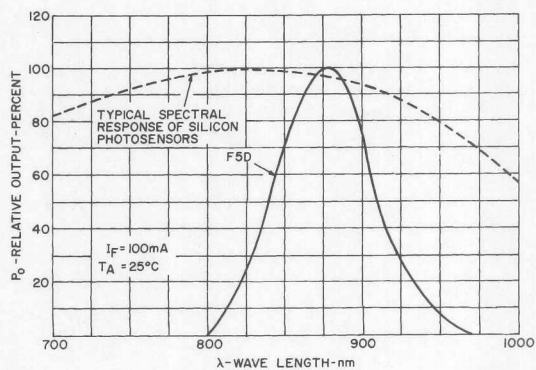


Fig. 6. Output vs. Wavelength

ST1030-99

TYPICAL CHARACTERISTICS

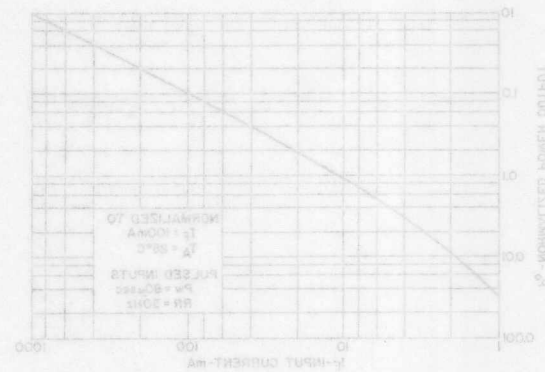


Fig. 1. Power Output vs. Input Current

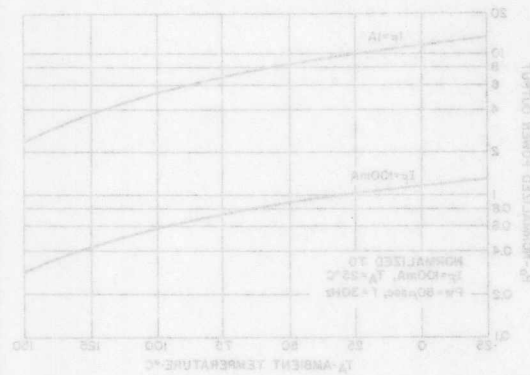


Fig. 2. Power Output vs. Temperature

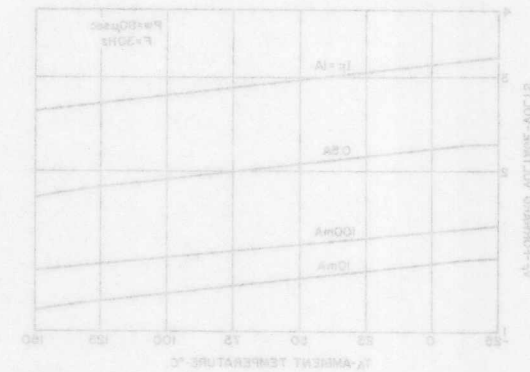


Fig. 3. Forward Voltage vs. Temperature

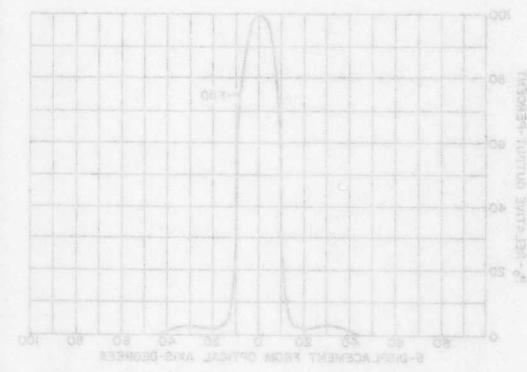


Fig. 4. Typical Radiation Pattern

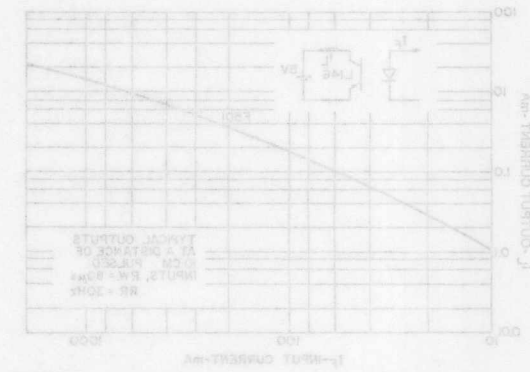


Fig. 5. Output vs. Input with LMG Detector

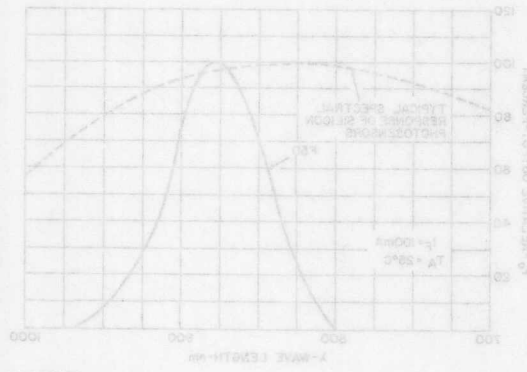
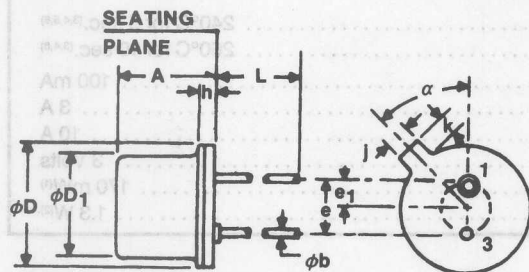


Fig. 6. Output vs. Wavelength

PACKAGE DIMENSIONS



ST1331

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	.155	—	3.93	
ϕb	.016	.021	.407	.533	
ϕD	.209	.230	5.31	5.84	
ϕD_1	.180	.188	4.57	4.77	
e	.100	NOM.	2.54	NOM.	2
e_1	.050	NOM.	1.27	NOM.	2
h	—	.030	—	.76	
j	.031	.044	.79	1.11	
k	.036	.046	.91	1.16	1
L	1.00	—	25.4	—	
α	45°	45°	45°	45°	3

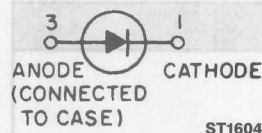
DESCRIPTION

The F5E series is 880nm LEDs in a wide angle, TO-46 package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level

PACKAGE OUTLINE



NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Continuous Forward Current	100 mA
Forward Current (pw, 10μS; 100 Hz)	3 A
Forward Current (pw, 1μS; 200 Hz)	10 A
Reverse Voltage	3 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 100 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
Peak Emission Wavelength	λ_p		880		nm	$I_F = 100 \text{ mA}$
Emission Angle at ½ Power	θ		±40		Degrees	
Total Power F5E1	P_o	12.0		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Total Power F5E2	P_o	9.0		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Total Power F5E3	P_o	10.5		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r		1.5		μS	
Fall Time 100-10% of output	t_f		1.5		μS	

NOTES

1. Derate power dissipation linearly 1.70 mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/8" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_o , is the total power radiated by the device into a solid angle of 2π steradians.

TYPICAL CHARACTERISTICS

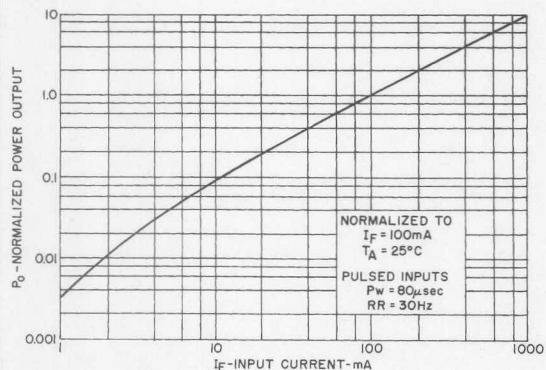


Fig. 1. Power Output vs. Input Current

ST1025

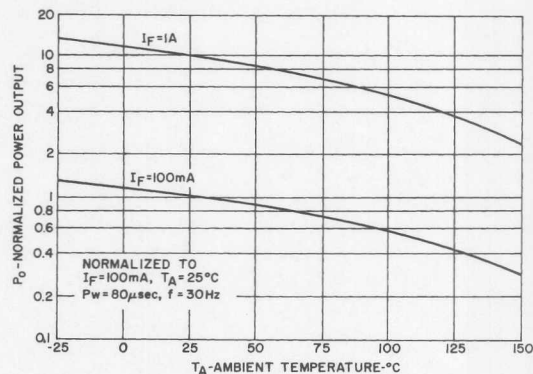


Fig. 2. Power Output vs. Temperature

ST1026

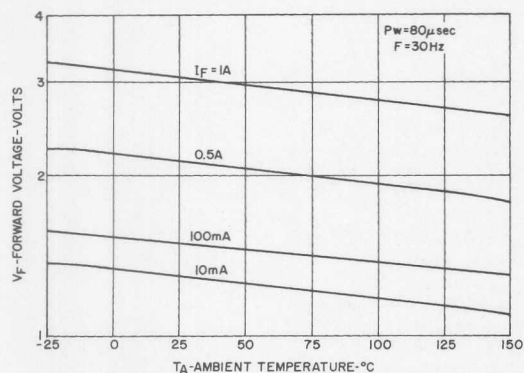


Fig. 3. Forward Voltage vs. Temperature

ST1027

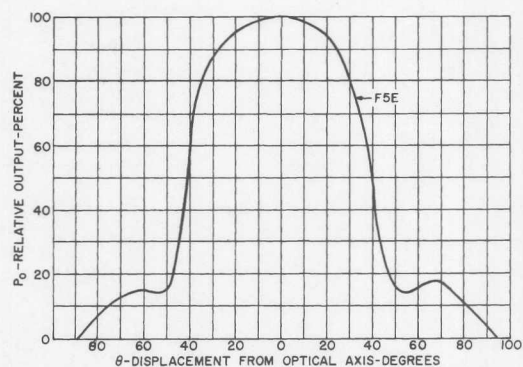


Fig. 4. Typical Radiation Pattern

ST1028-98

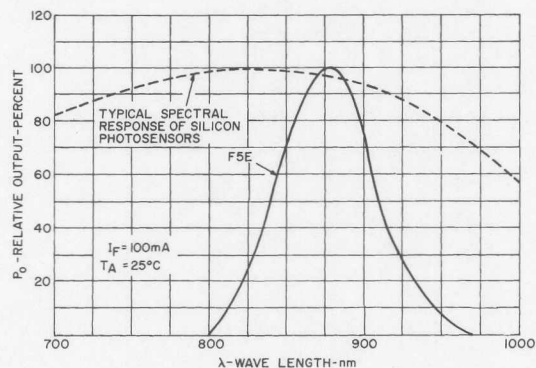
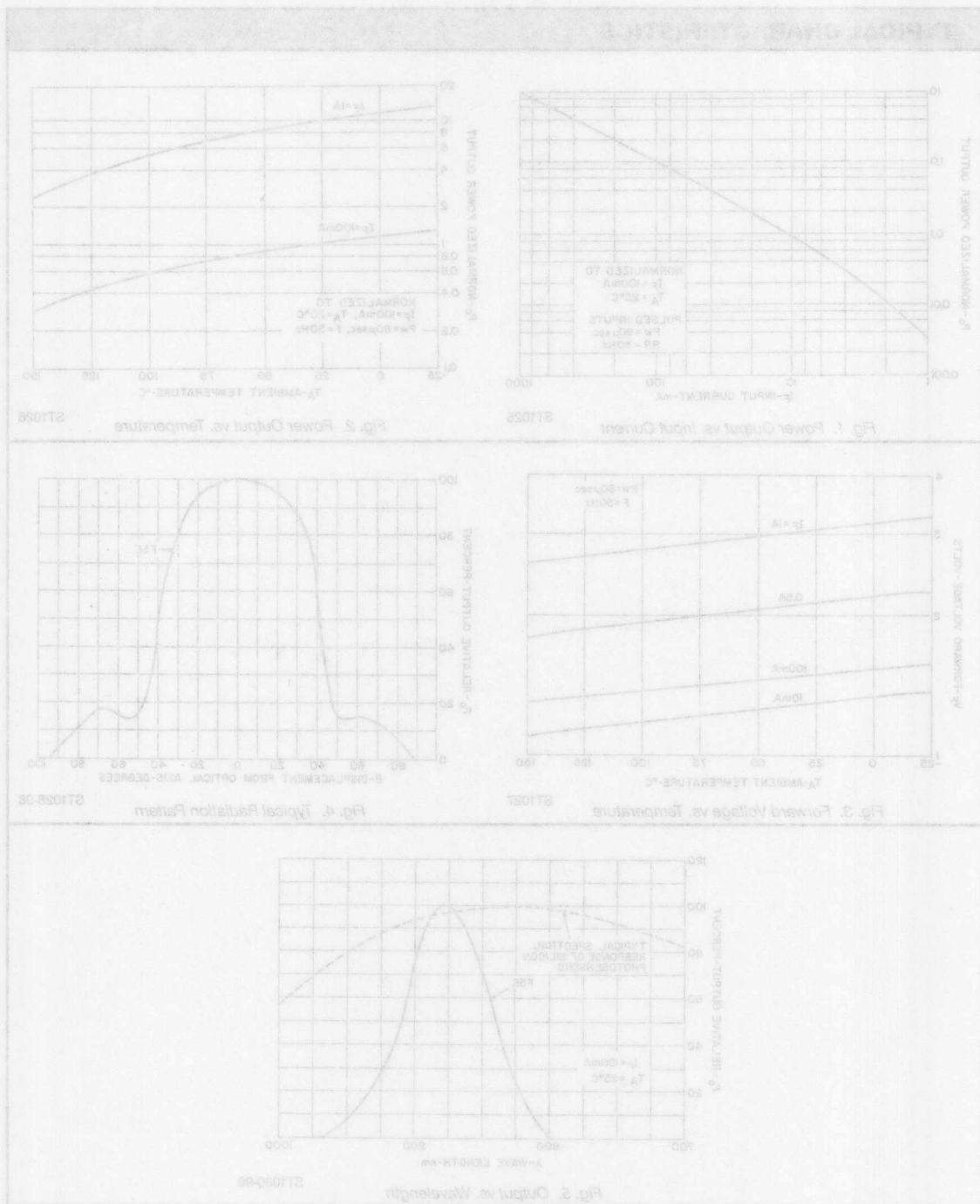
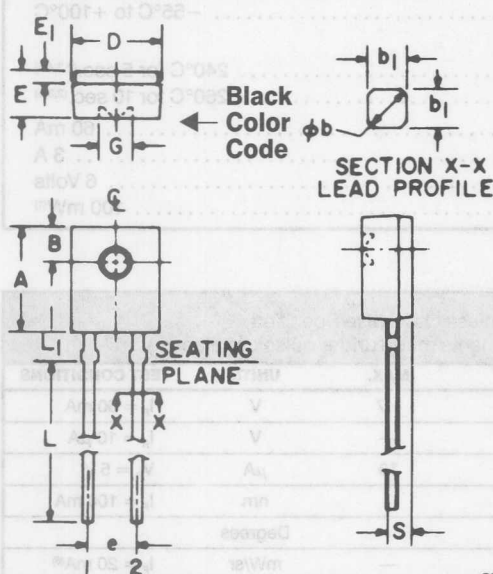


Fig. 5. Output vs. Wavelength

ST1030-98



PACKAGE DIMENSIONS



DESCRIPTION

The F5F1 is a 940nm LED encapsulated in a clear, wide angle, sideloooker package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the L14Q series phototransistor
- Plastic package with a color stripe for easy recognition from phototransistor
- High irradiance level

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
φb	.60	.75	.024	.030	1
b ₁	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E ₁	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L ₁	1.40	1.65	.055	.065	
S	.83	.94	.033	.037	3

PACKAGE OUTLINE



ST1604

NOTES:

1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27 mm (.050") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25 mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	−55°C to +100°C
Operating Temperature	−55°C to +100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Continuous Forward Current	60 mA
Forward Current (pw, 1μS; ≤ 33 Hz)	3 A
Reverse Voltage	6 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 5 \text{ V}$
Peak Emission Wavelength	λ_p		940		nm	$I_F = 100 \text{ mA}$
Emission Angle at ½ Power	θ		±35		Degrees	
Radiant Intensity	I_e	0.28		—	mW/sr	$I_F = 20 \text{ mA}^{(6)}$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C ambient.
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. I_e measured with a 0.45 cm aperture placed 1.6 cm from the tip of the lens on the lens centerline perpendicular to the plane of the leads.

TYPICAL CHARACTERISTICS

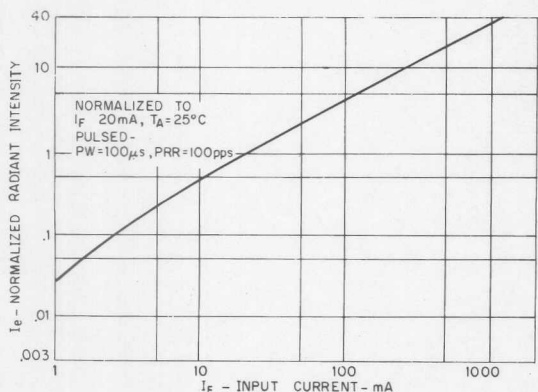


Fig. 1. Radiant Intensity vs. Input Current

ST1033

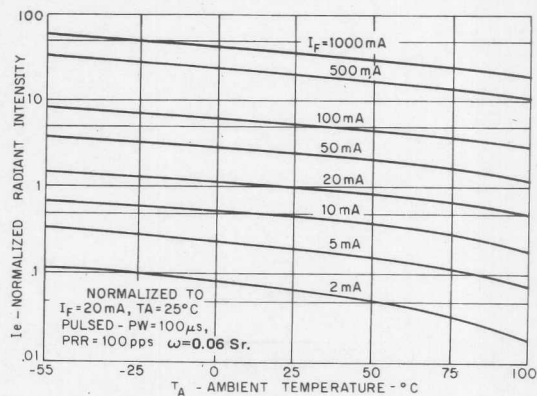


Fig. 2. Radiant Intensity vs. Temperature

ST1038

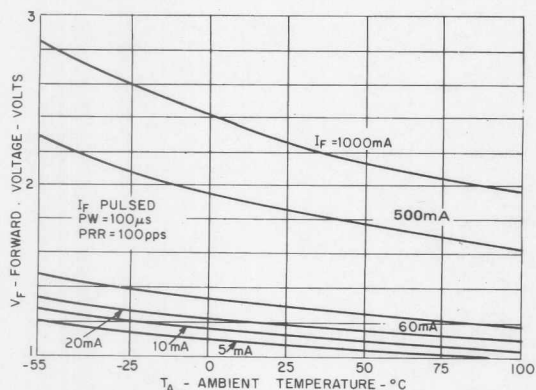


Fig. 3. Forward Voltage vs. Temperature

ST1034

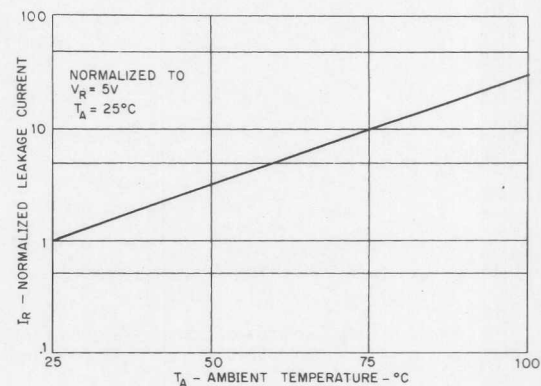


Fig. 4. Leakage Current vs. Temperature

ST1037

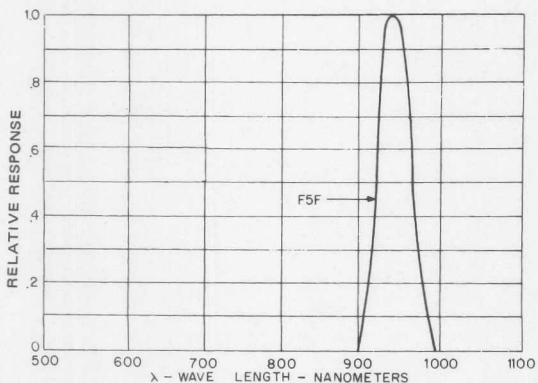


Fig. 5. Spectral Response

ST1035

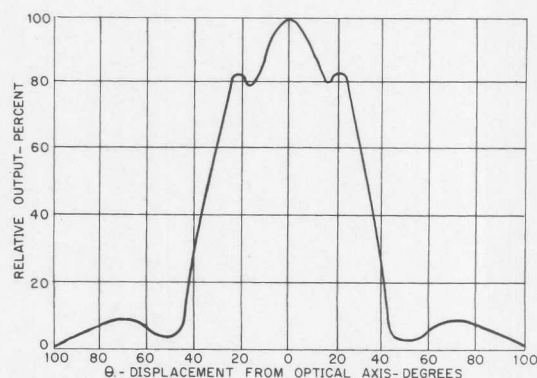


Fig. 6. Typical Radiation Pattern

ST1036

Fig. 1. Radiant Intensity vs. Input Current

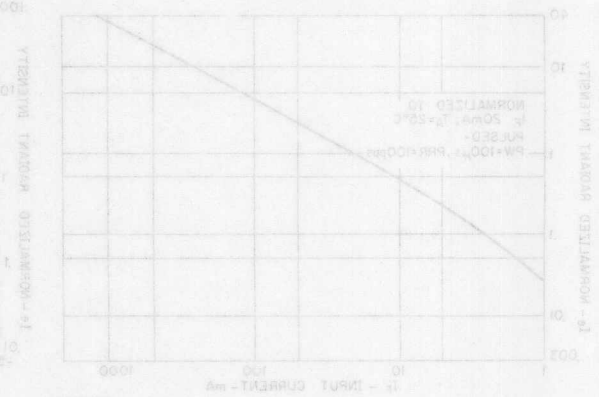


Fig. 1. Radiant Intensity vs. Input Current

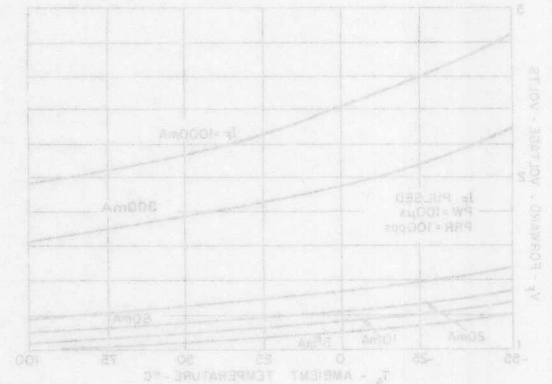


Fig. 3. Forward Voltage vs. Temperature

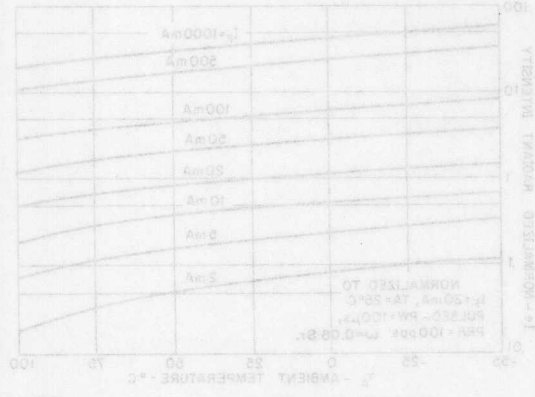


Fig. 2. Radiant Intensity vs. Temperature

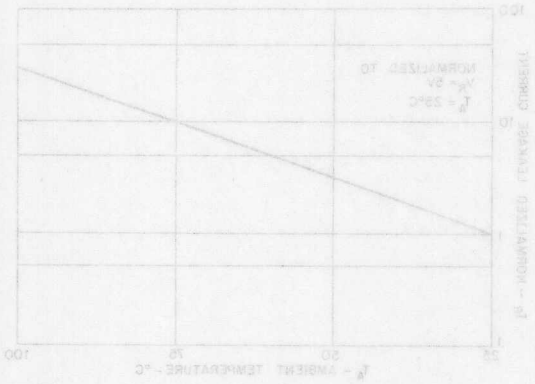


Fig. 4. Radiant Intensity vs. Temperature

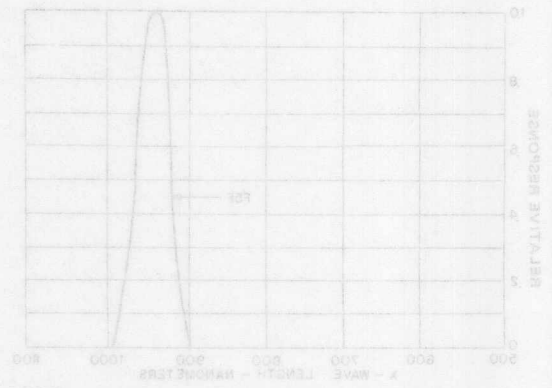


Fig. 5. Spectral Response

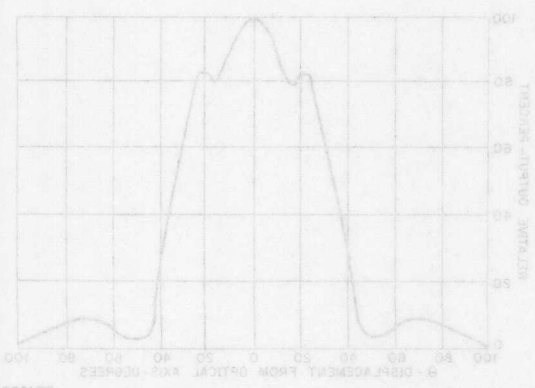
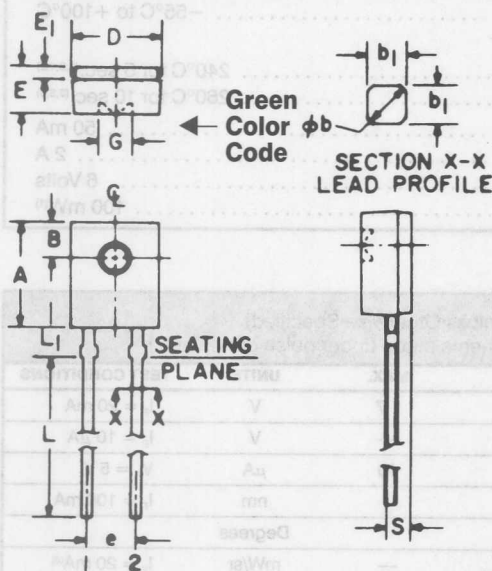


Fig. 6. Typical Radiation Pattern

PACKAGE DIMENSIONS



DESCRIPTION

The F5G1 is an 880nm LED encapsulated in a clear, wide angle, sideloader package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the L14Q series phototransistor
- Plastic package with a color stripe for easy recognition from phototransistor
- High irradiance level

ST1334

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
ϕb	.60	.75	.024	.030	1
b ₁	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E ₁	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L ₁	1.40	1.65	.055	.065	
S	.83	.94	.033	.037	3

PACKAGE OUTLINE



ST1604

NOTES:

1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27 mm (.050") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25 mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to +100°C
Operating Temperature	-55°C to +100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. (2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. (2,3,5)
Continuous Forward Current	50 mA
Forward Current (pw, 1μS; ≤ 33 Hz)	2 A
Reverse Voltage	6 Volts
Power Dissipation	100 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

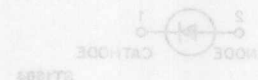
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—	—	1.7	V	$I_F = 20 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0	—	—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 5 \text{ V}$
Peak Emission Wavelength	λ_p	—	880	—	nm	$I_F = 100 \text{ mA}$
Emission Angle at ½ Power	θ	—	±35	—	Degrees	
Radiant Intensity	I_e	0.6	—	—	mW/sr	$I_F = 20 \text{ mA}^{(6)}$

NOTES

1. Derate power dissipation linearly 1.33 mW/°C above 25°C ambient.
2. RMA flux is recommended.
3. Methanol or Isopropanol alcohols are recommended as cleaning agents.
4. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. I_e measured with a 0.45 cm aperture placed 1.6 cm from the tip of the lens on the lens centerline perpendicular to the plane of the leads.

INCHES	MILLIMETERS	INCHES	MILLIMETERS	INCHES	MILLIMETERS
1	25.4	1/2	12.7	1/4	6.35
3/8	9.52	1/8	3.18	1/16	1.59
5/16	7.94	3/16	4.76	1/32	0.79
7/16	11.18	1/4	6.35	1/64	0.39
9/16	14.94	5/16	7.94	1/128	0.19
1 1/16	18.18	3/8	9.52	1/256	0.09
1 1/8	20.64	7/16	11.18	1/512	0.04
1 1/4	25.4	1	25.4	1/1024	0.02
1 1/2	38.1	1 1/8	31.75		



- NOTES:
1. TWO LEADS, LEAD ORIGIN SECTION DIMENSIONS UNCONTROLLED WITHIN ±0.25 mm (0.010") OF SEATING PLANE.
 2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN ±0.25 mm (0.010") OF TRUE POSITION.
 3. AS MEASURED AT THE SEATING PLANE.
 4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

TYPICAL CHARACTERISTICS

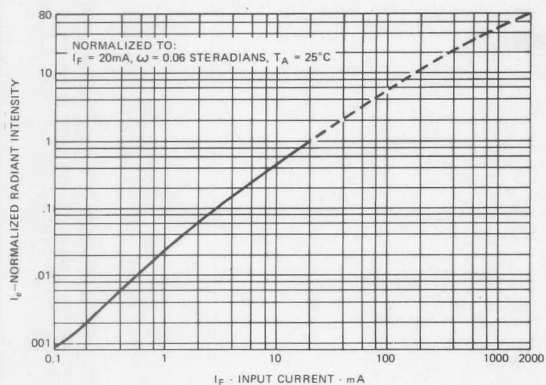


Fig. 1. Radiant Intensity vs. Input Current

ST1041

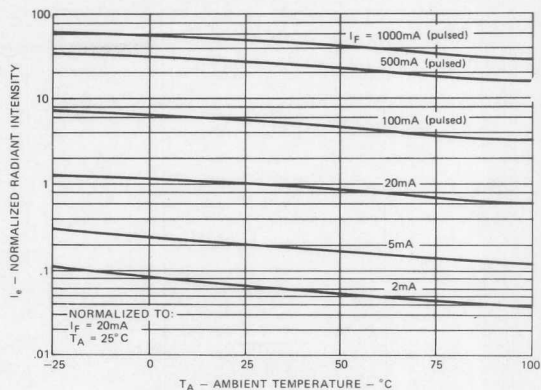


Fig. 2. Radiant Intensity vs. Temperature

ST1046

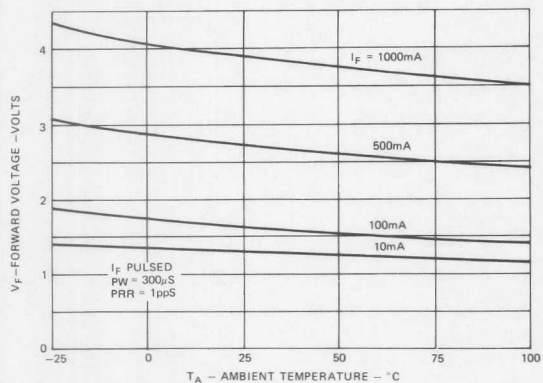


Fig. 3. Forward Voltage vs. Temperature

ST1042

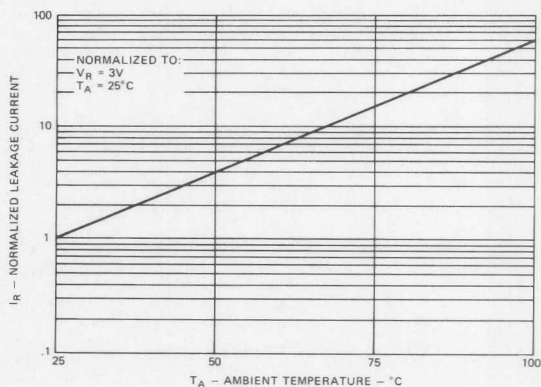


Fig. 4. Leakage Current vs. Temperature

ST1045

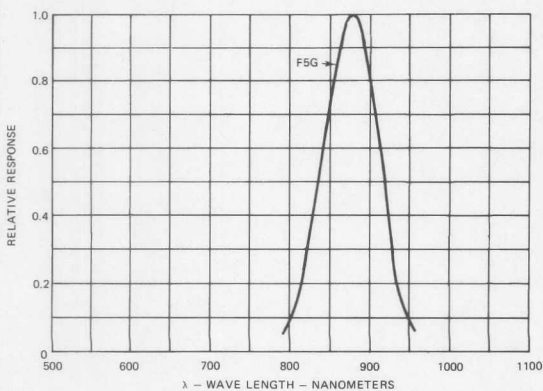


Fig. 5. Spectral Response

ST1043

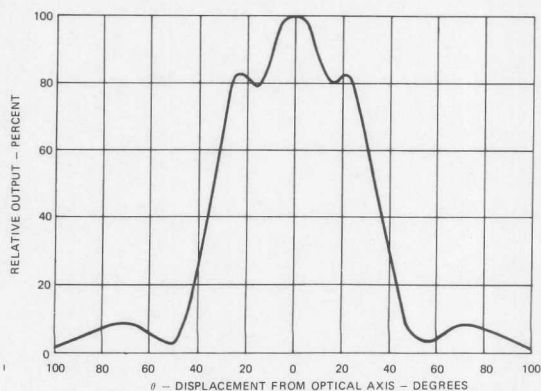


Fig. 6. Typical Radiation Pattern

ST1044

TYPICAL CHARACTERISTICS

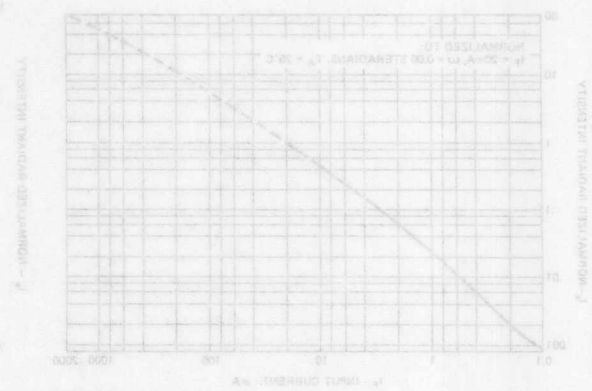


Fig. 1: Radiant Intensity vs. Input Current

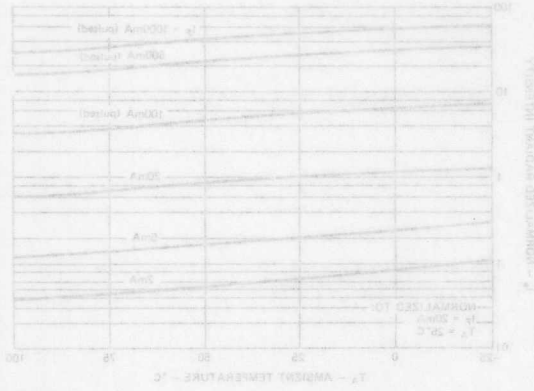


Fig. 2: Radiant Intensity vs. Temperature

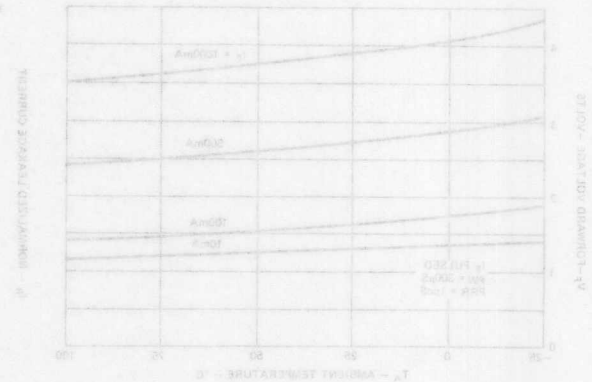


Fig. 3: Forward Voltage vs. Temperature

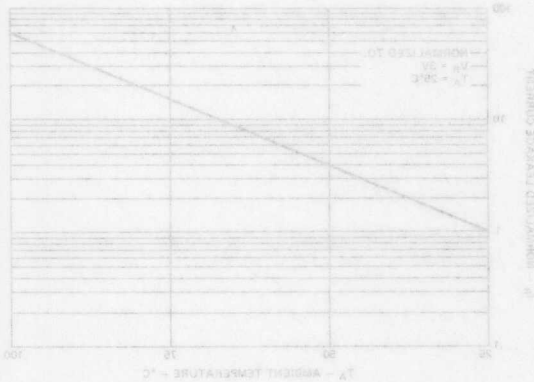


Fig. 4: Leakage Current vs. Temperature

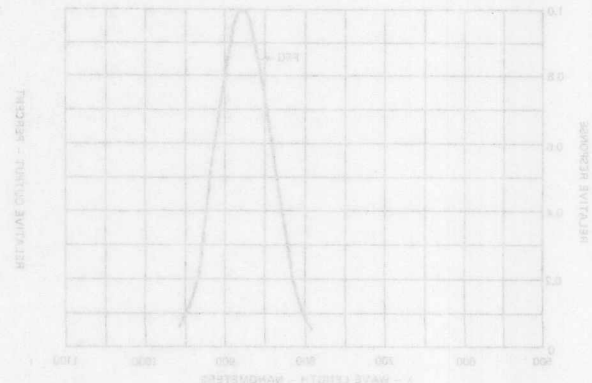


Fig. 5: Spectral Response

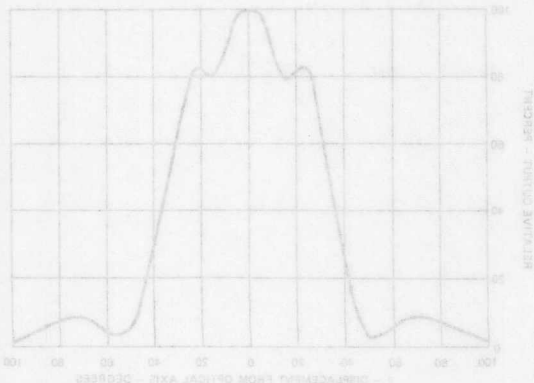
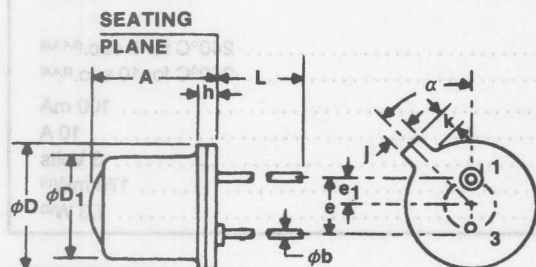


Fig. 6: Typical Radiation Pattern

LED55B/C, LED56

3

PACKAGE DIMENSIONS



DESCRIPTION

The LED55B/C and LED56 are 940nm LEDs in a narrow angle, TO-46 package.

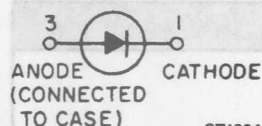
FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level

ST1332

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.255		6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi D1	.180	.188	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e1	.050 NOM.		1.27 NOM.		2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
alpha	45°	45°	45°	45°	3

PACKAGE OUTLINE



ST1604

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + 025 - 000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

LED55B/C, LED56

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Continuous Forward Current	100 mA
Forward Current (pw, 1μs; 200 Hz)	10 A
Reverse Voltage	3 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 100 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
Peak Emission Wavelength	λ_p		940		nm	$I_F = 100 \text{ mA}$
Emission Angle at ½ Power	θ		±8		Degrees	
Total Power LED55B	P_o	3.5		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Total Power LED55C	P_o	5.4		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Total Power LED56	P_o	1.5		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r		1.0		μs	
Fall Time 100-10% of output	t_f		1.0		μs	

NOTES

1. Derate power dissipation linearly 1.70 mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_o , is the total power radiated by the device into a solid angle of 2π steradians.

TYPICAL CHARACTERISTICS

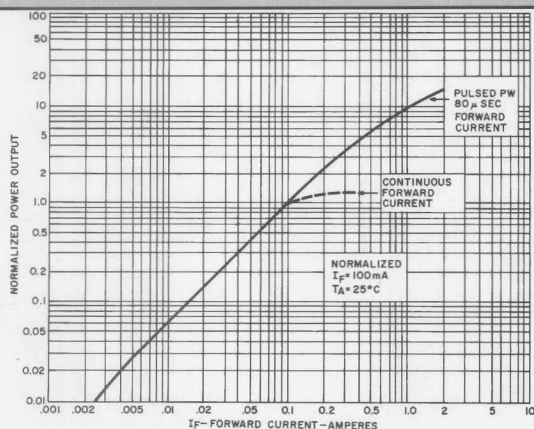


Fig. 1. Power Output vs. Input Current ST1052

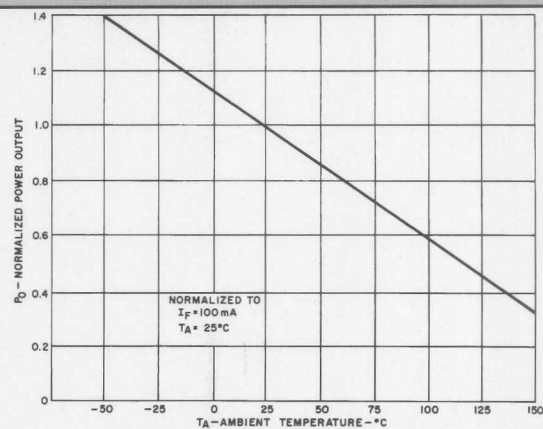


Fig. 2. Power Output vs. Temperature ST1057

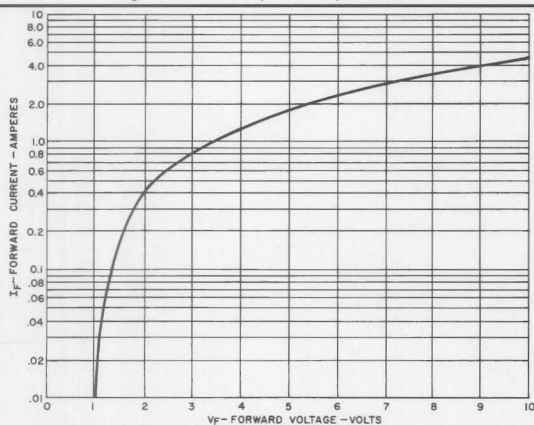


Fig. 3. Forward Voltage vs. Forward Current ST1053

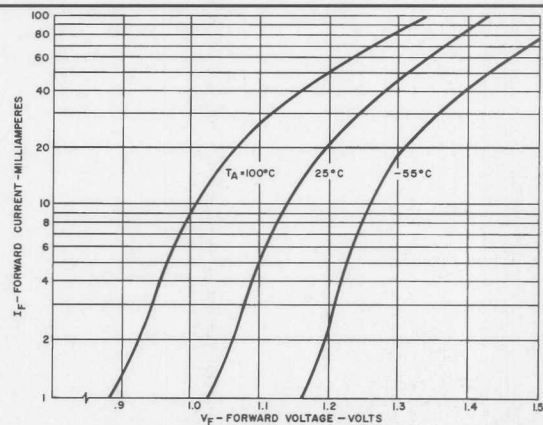


Fig. 4. Forward Voltage vs. Forward Current ST1056

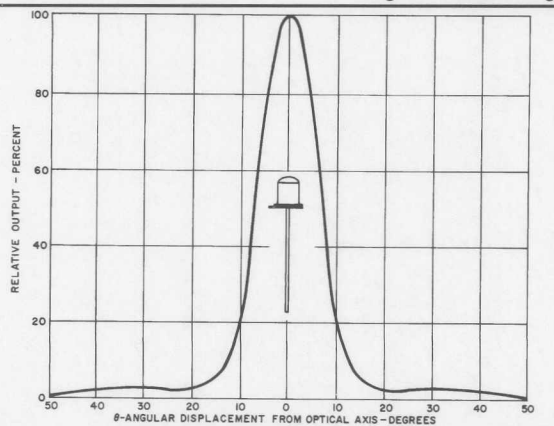
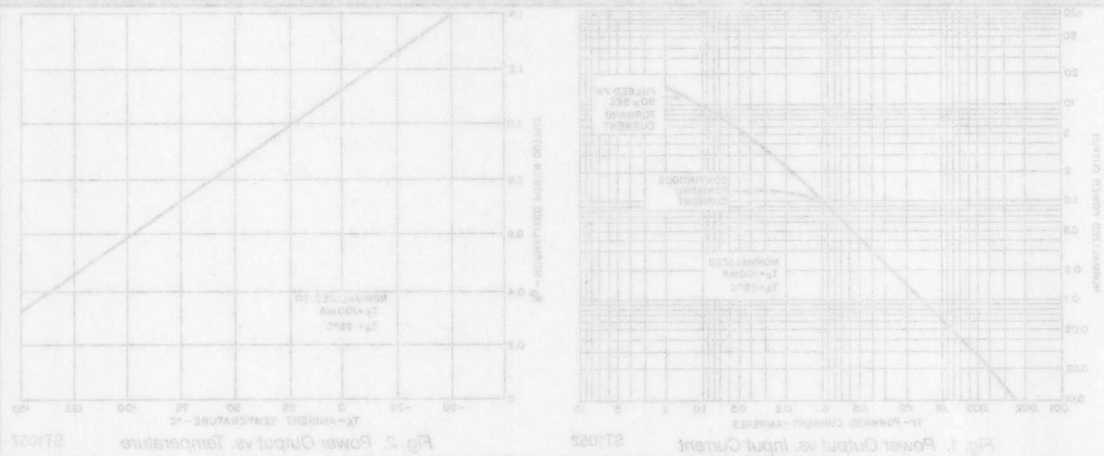
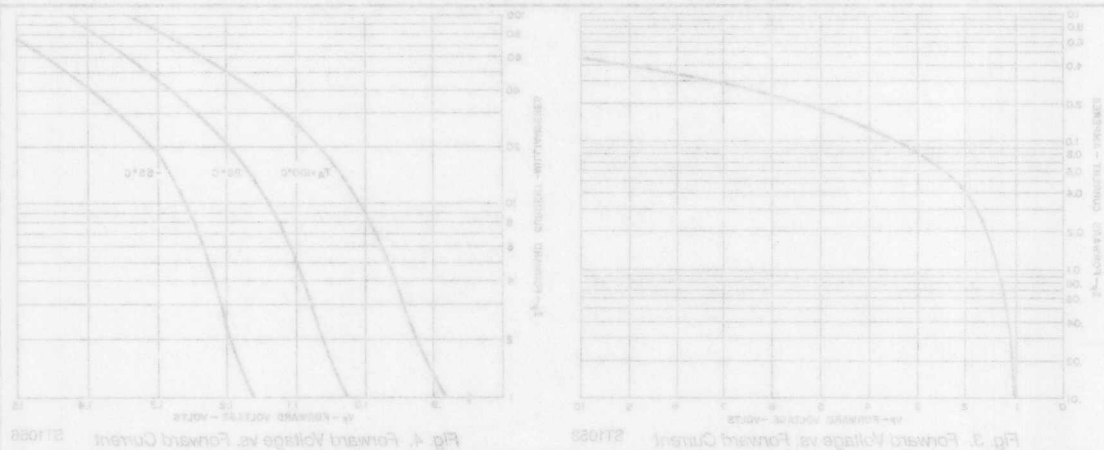
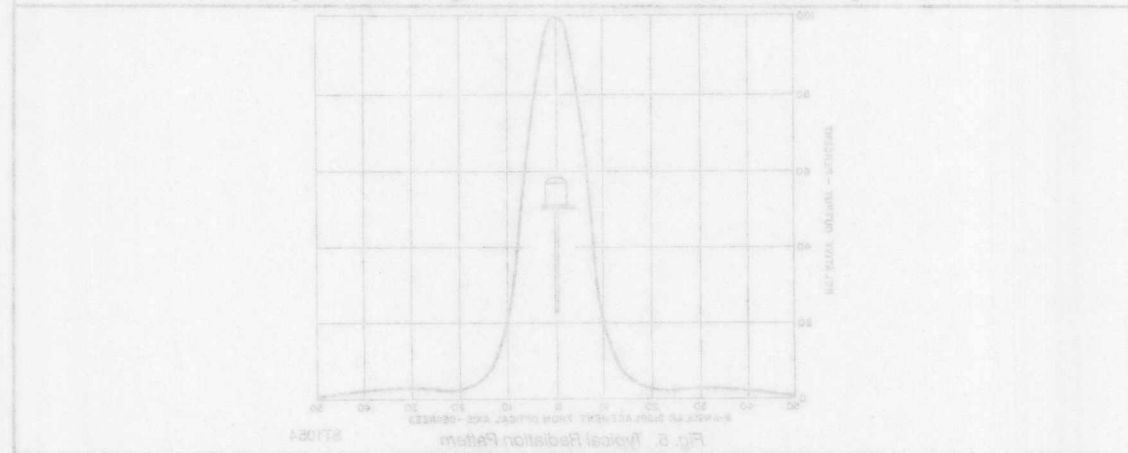


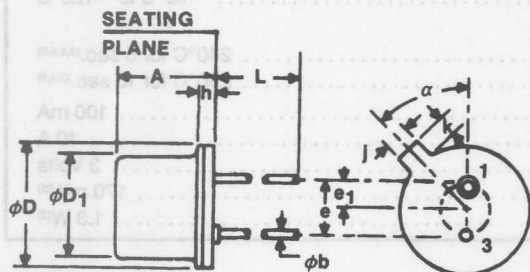
Fig. 5. Typical Radiation Pattern ST1054



LED55BF/CF, LED56F

3

PACKAGE DIMENSIONS



ST1331

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.155		3.93	
ϕb	.016	.021	.407	.533	
ϕD	.209	.230	5.31	5.84	
ϕD_1	.180	.188	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e ₁	.050 NOM.		1.27 NOM.		2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
α	45°	45°	45°	45°	3

PACKAGE OUTLINE



ST1604

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAX. DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + 025 - 000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

DESCRIPTION

The LED55BF/CF and LED56F are 940nm LEDs in a wide angle, TO-46 package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level

LED55BF/CF, LED56F

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to $+150^\circ\text{C}$
Operating Temperature	-65°C to $+125^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Continuous Forward Current	100 mA
Forward Current (pw, $1\mu\text{S}$; 200 Hz)	10 A
Reverse Voltage	3 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

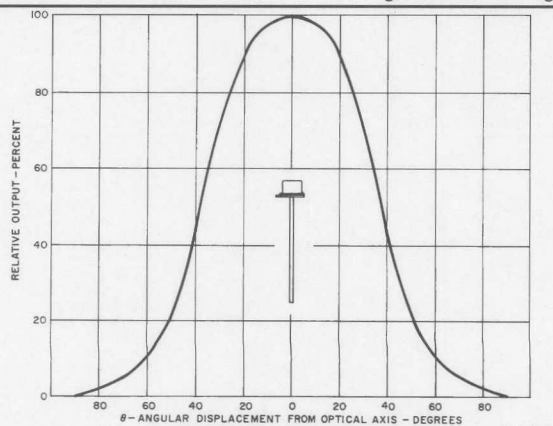
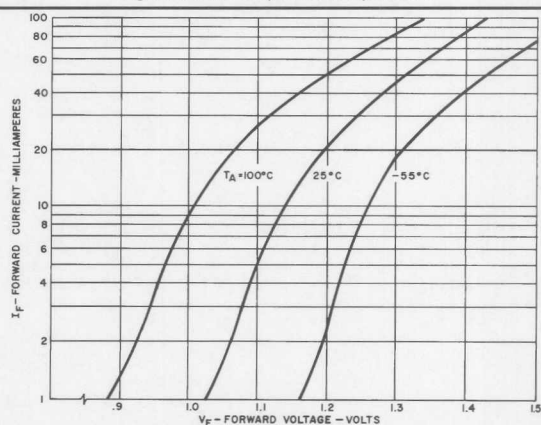
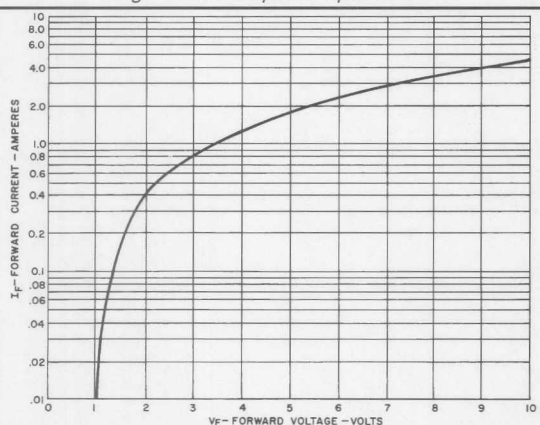
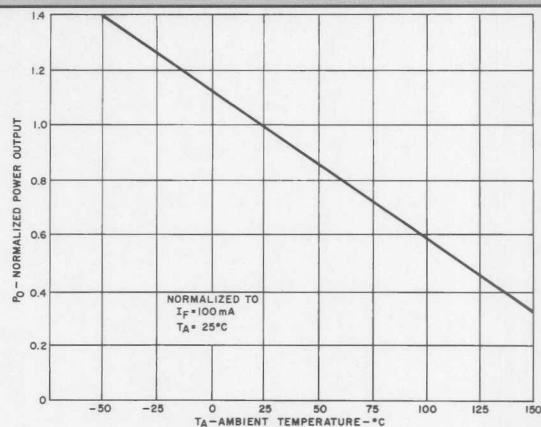
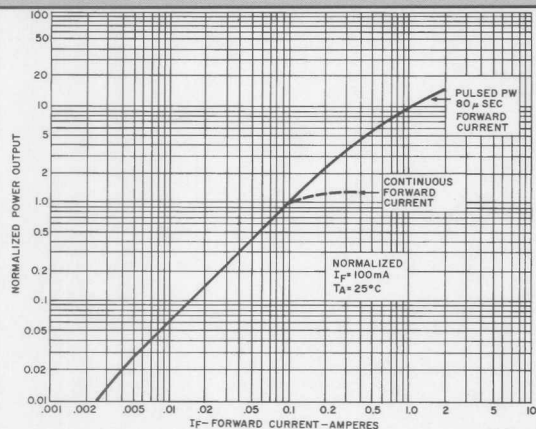
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 100\text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3\text{ V}$
Peak Emission Wavelength	λ_p		940		nm	$I_F = 100\text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ		± 40		Degrees	
Total Power LED55BF	P_o	3.5		—	mW	$I_F = 100\text{ mA}^{(7)}$
Total Power LED55CF	P_o	5.4		—	mW	$I_F = 100\text{ mA}^{(7)}$
Total Power LED56F	P_o	1.5		—	mW	$I_F = 100\text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r		1.0		μS	
Fall Time 100-10% of output	t_f		1.0		μS	

NOTES

1. Derate power dissipation linearly 1.70 mW/ $^\circ\text{C}$ above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/ $^\circ\text{C}$ above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_o , is the total power radiated by the device into a solid angle of 2π steradians.

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS



Fig. 1. Power Output vs. Input Current

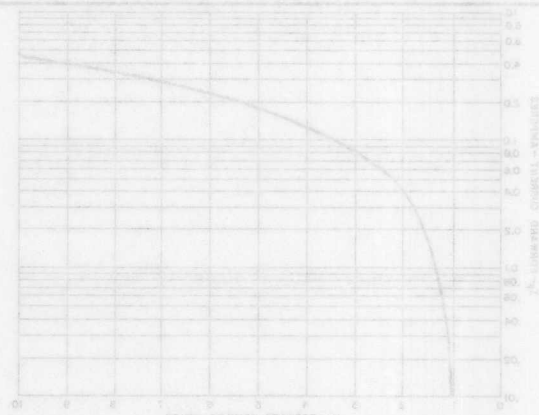


Fig. 3. Forward Voltage vs. Forward Current

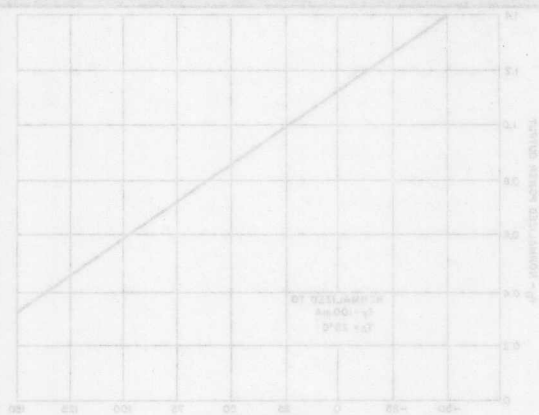


Fig. 5. Power Output vs. Temperature

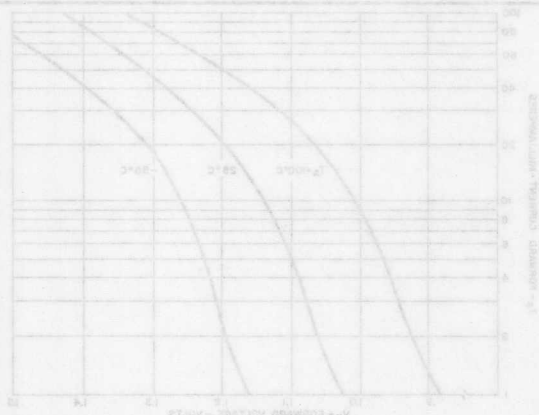


Fig. 4. Forward Voltage vs. Forward Current

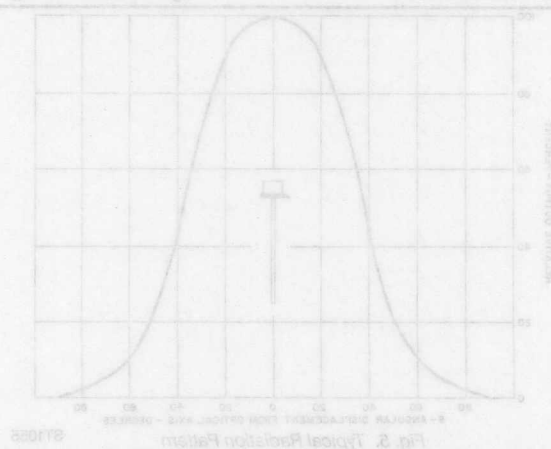
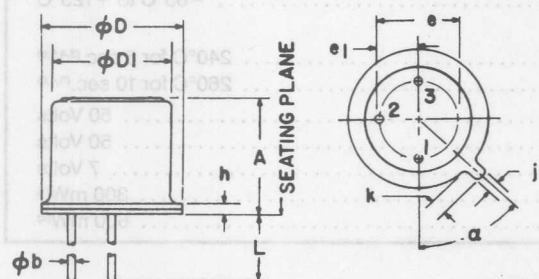


Fig. 2. Typical Radiation Pattern

PACKAGE DIMENSIONS



ST1336

DESCRIPTION

The L14C series is a silicon phototransistor mounted in a wide angle, TO-18 package.

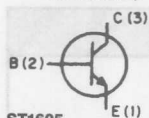
FEATURES

- Hermetically sealed package
- Wide reception angle

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	.210	—	5.34	
ϕb	.016	.021	.406	.534	
ϕD	.209	.230	5.30	5.85	
ϕD_1	.178	.195	4.52	4.96	
e	.100	NOM.	2.54	NOM.	2
e_1	.050	NOM.	1.27	NOM.	2
h	—	.030	—	.76	
j	.036	.046	.91	1.17	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
α	45°	45°	45°	45°	3

PACKAGE OUTLINE

(COLLECTOR
CONNECTED
TO CASE)



ST1605

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + 025 - 000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to $+150^\circ\text{C}$
Operating Temperature	-65°C to $+125^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Collector-Emitter Breakdown Voltage	50 Volts
Collector-Base Breakdown Voltage	50 Volts
Emitter-Base Breakdown Voltage	7 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	50	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	7.0	—	—	V	$I_E = 100\mu\text{A}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	50	—	—	V	$I_C = 100\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 20\text{ V}$, $E_e = 0$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 40	—	Degrees	
On-State Collector Current L14C1	$I_{C(ON)}$	1.0	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Collector Current L14C2	$I_{C(ON)}$	0.5	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Collector Current L14C2	$I_{C(ON)}$	1.0	—	—	mA	$E_e = 6.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
Turn-On Time	t_{on}	—	5	—	μS	$I_C = 2\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Turn-Off Time	t_{off}	—	5	—	μS	$I_C = 2\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.40\text{ mA}$, $E_e = 6.0\text{ mW/cm}^2$ ^(7,8)

NOTES

1. Derate power dissipation linearly $3.00\text{ mW}/^\circ\text{C}$ above 25°C ambient.
2. Derate power dissipation linearly $6.00\text{ mW}/^\circ\text{C}$ above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
8. Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm^2 is approximately equivalent to a tungsten source, at 2870°K , of 10 mW/cm^2 .

TYPICAL CHARACTERISTICS

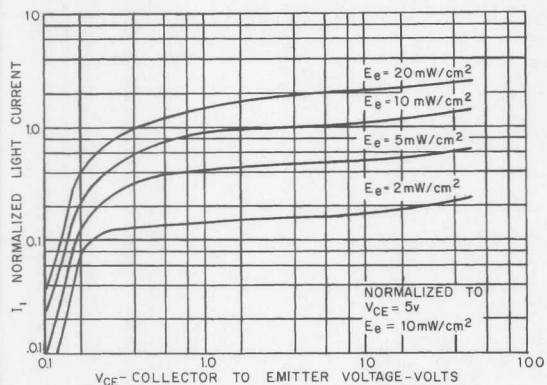


Fig. 1. Light Current vs. Collector to Emitter Voltage ST1062

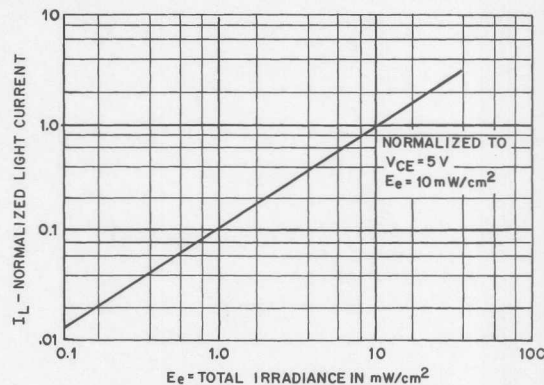


Fig. 2. Normalized Light Current vs. Radiation ST1067

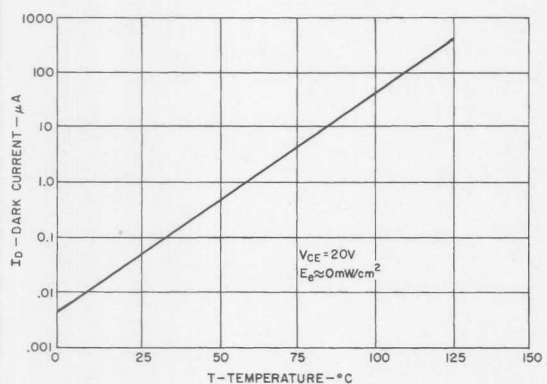


Fig. 3. Dark Current vs. Temperature ST1063

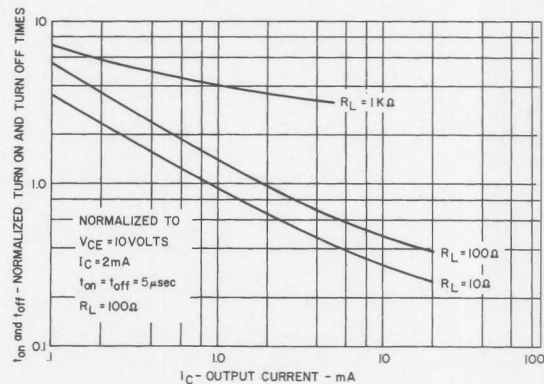


Fig. 4. Switching Speed vs. Output Current ST1066

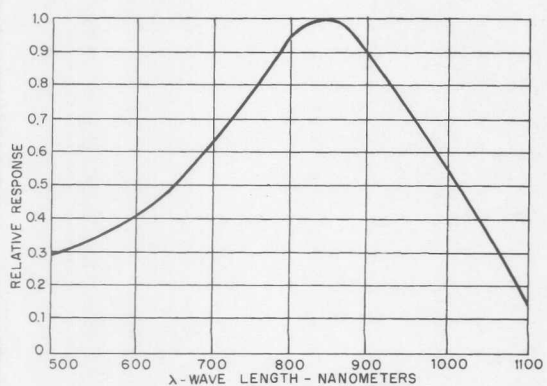


Fig. 5. Spectral Response ST1064

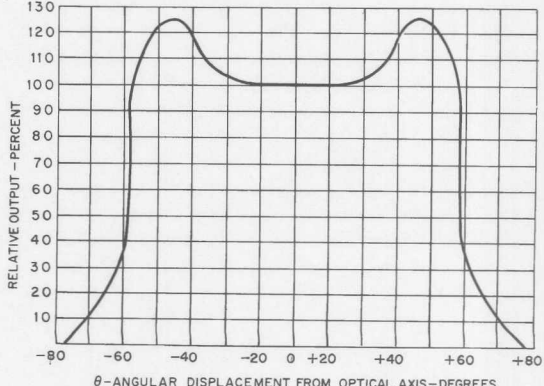
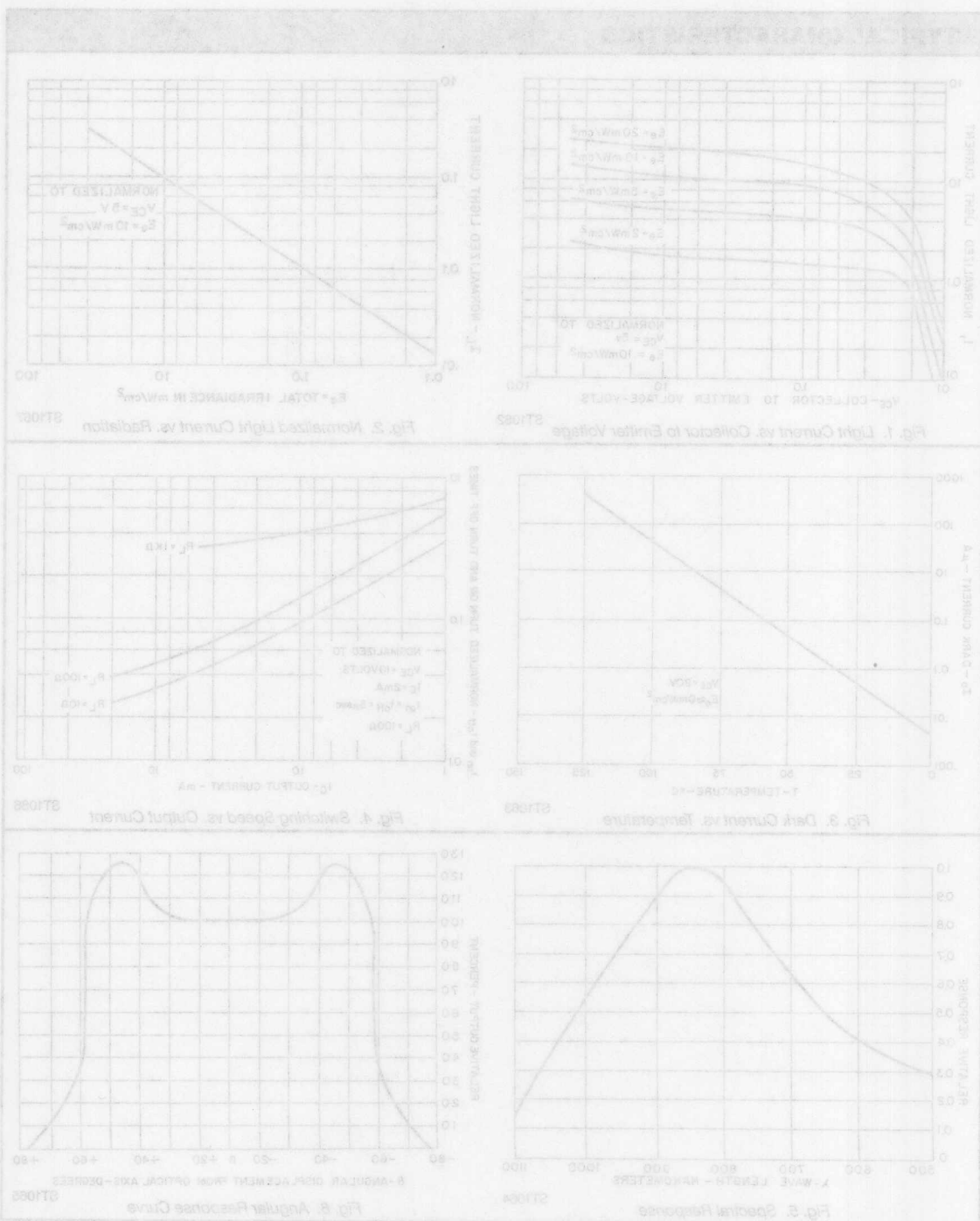
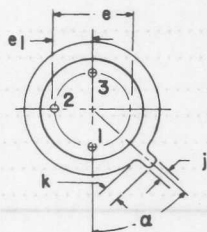
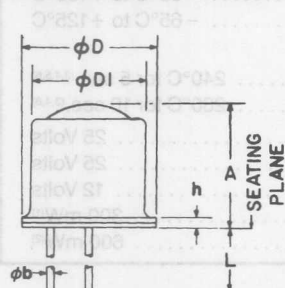


Fig. 6. Angular Response Curve ST1065



PACKAGE DIMENSIONS



ST1333

DESCRIPTION

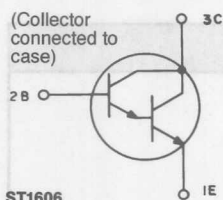
The L14FX is a silicon photodarlington mounted in a narrow angle, TO-18 package.

FEATURES

- Hermetically sealed package
- Narrow reception angle

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.225	.255	5.71	6.47	
ϕb	.016	.021	.407	.533	
ϕD	.209	.230	5.31	5.84	
ϕDI	.178	.195	4.52	4.96	
e	.100	NOM	2.54	NOM	2
e_1	.050	NOM	1.27	NOM	2
h	—	.030	—	.76	
j	.036	.046	.92	1.16	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
α	45°	45°	45°	45°	3

PACKAGE OUTLINE



ST1606

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO A MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Collector-Emitter Breakdown Voltage	25 Volts
Collector-Base Breakdown Voltage	25 Volts
Emitter-Base Breakdown Voltage	12 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	25	—	—	V	$I_F = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	12	—	—	V	$I_E = 100\text{ V}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	25	—	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 12\text{ V}$, $E_e = 0$
Reception Angle at ½ Sensitivity	θ	—	±6	—	Degrees	
On-State Collector Current L14F1	$I_{C(ON)}$	3.0	—	—	mA	$E_e = .05\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁷⁾
On-State Collector Current L14F2	$I_{C(ON)}$	1.0	—	—	mA	$E_e = .05\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁷⁾
Rise Time	t_r	—	300	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	250	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly 3.00mW/°C above 25°C ambient.
2. Derate power dissipation linearly 6.00mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
8. Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 0.05 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 0.2 mW/cm².

TYPICAL CHARACTERISTICS

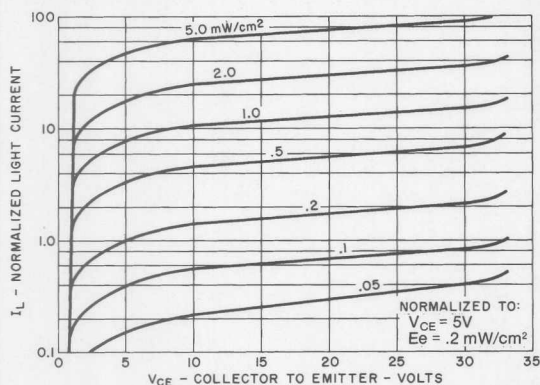


Fig. 1. Light Current vs. Collector to Emitter Voltage

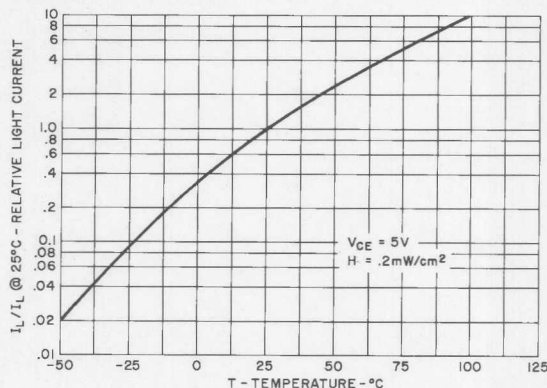


Fig. 2. Relative Light Current vs. Ambient Temperature

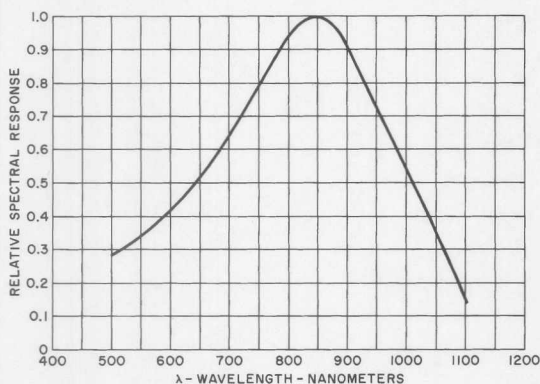


Fig. 3. Spectral Response Curve

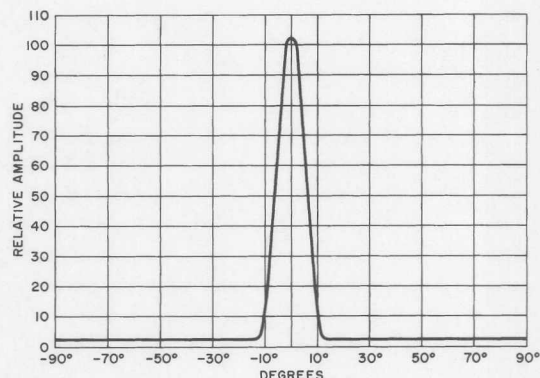


Fig. 4. Angular Response

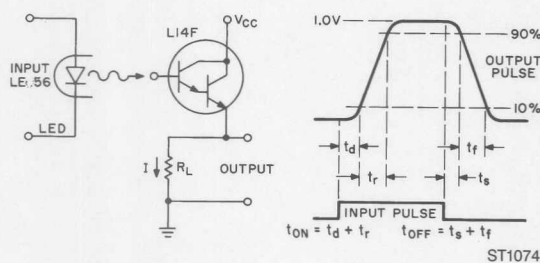


Fig. 5. Test Circuit and Voltage Waveforms

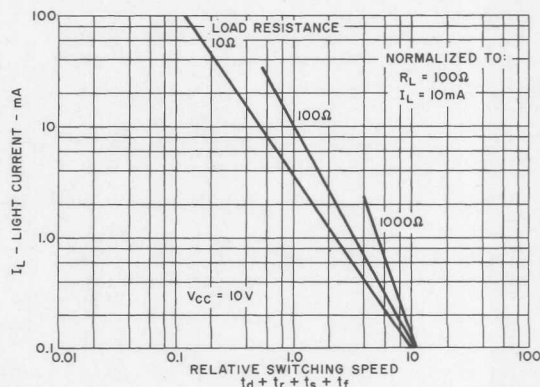
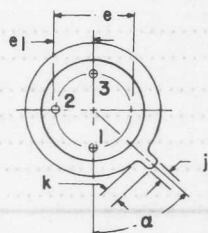
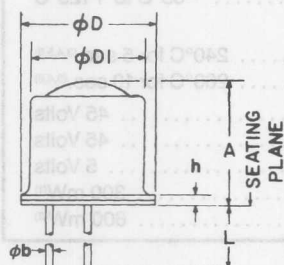


Fig. 6. Light Current vs. Relative Switching Speed

PACKAGE DIMENSIONS



ST1333

DESCRIPTION

The L14G series is a silicon phototransistor mounted in a narrow angle, TO-18 package.

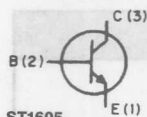
FEATURES

- Hermetically sealed package
- Narrow reception angle

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.225	.255	5.71	6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi DI	.178	.195	4.52	4.96	
e	.100 NOM		2.54 NOM		2
e1	.050 NOM		1.27 NOM		2
h	—	.030	—	.76	
j	.036	.046	.92	1.16	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
alpha	45°	45°	45°	45°	3

PACKAGE OUTLINE

(COLLECTOR
CONNECTED
TO CASE)



ST1605

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to $+150^\circ\text{C}$
Operating Temperature	-65°C to $+125^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Collector-Emitter Breakdown Voltage	45 Volts
Collector-Base Breakdown Voltage	45 Volts
Emitter-Base Breakdown Voltage	5 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	45	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	45	—	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$, $E_e = 0$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 10	—	Degrees	
On-State Collector Current L14G1	$I_{C(ON)}$	6.0	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Collector Current L14G2	$I_{C(ON)}$	3.0	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Collector Current L14G3	$I_{C(ON)}$	12.0	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
Turn-On Time	t_{on}	—	8	—	μS	$I_C = 2\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Turn-Off Time	t_{off}	—	7	—	μS	$I_C = 2\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 1.0\text{ mA}$, $E_e = 3.0\text{ mW/cm}^2$ ^(7,8)

NOTES

- Derate power dissipation linearly $3.00\text{ mW}/^\circ\text{C}$ above 25°C ambient.
- Derate power dissipation linearly $6.00\text{ mW}/^\circ\text{C}$ above 25°C case.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
- Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm^2 is approximately equivalent to a tungsten source, at 2870°K of 10 mW/cm^2 .

TYPICAL CHARACTERISTICS

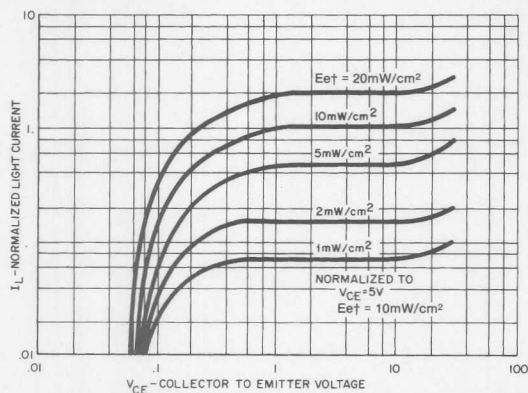


Fig. 1. Light Current vs. Collector to Emitter Voltage ST1082

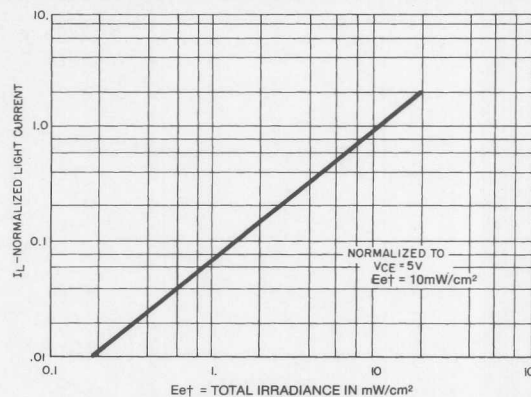


Fig. 2. Normalized Light Current vs. Radiation ST1087

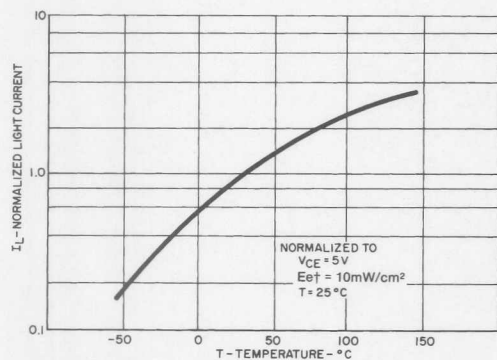


Fig. 3. Normalized Light Current vs. Temperature ST1083

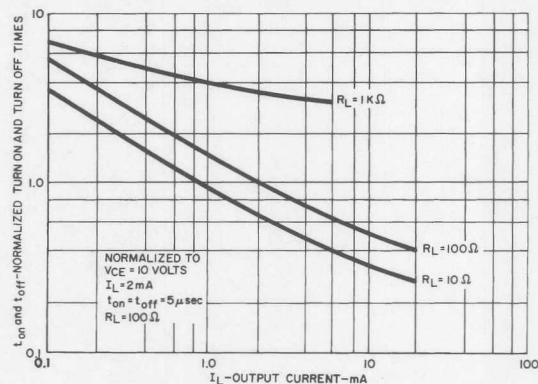


Fig. 4. Switching Times vs. Output Current ST1086

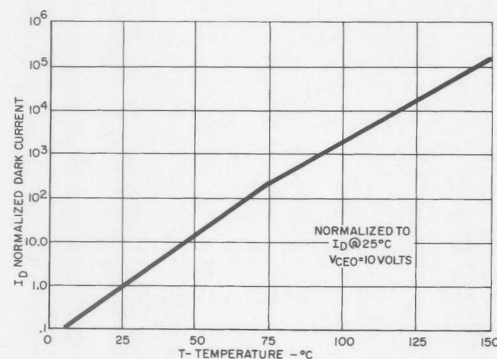


Fig. 5. Dark Current vs. Temperature ST1084

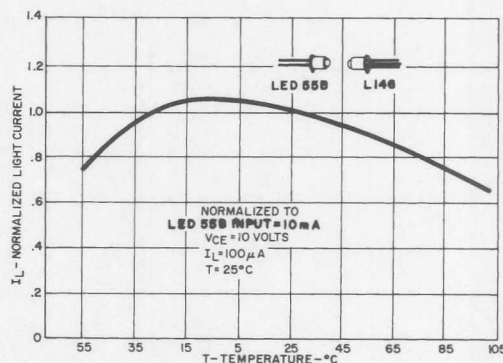


Fig. 6. Normalized Light Current vs. Temperature Both Emitter (LED55B) and Detector (L14G) at Same Temperature ST1085

TYPICAL CHARACTERISTICS

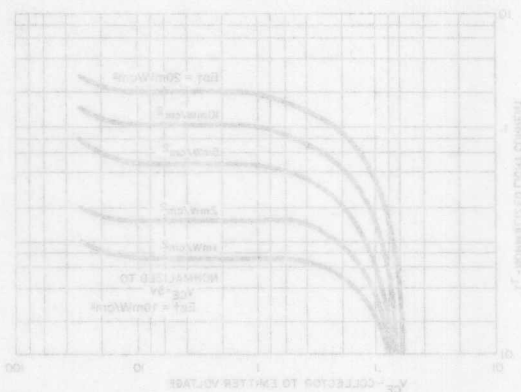


Fig. 1. Light Current vs. Collector to Emitter Voltage

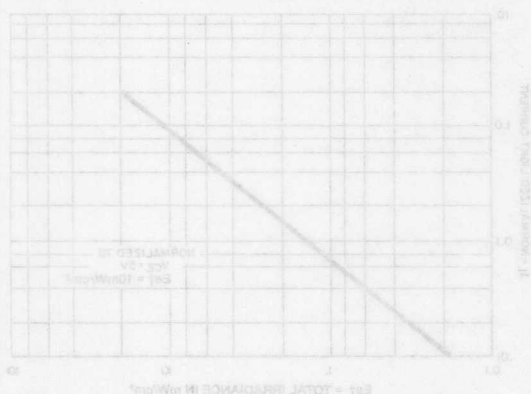


Fig. 2. Normalized Light Current vs. Radiation

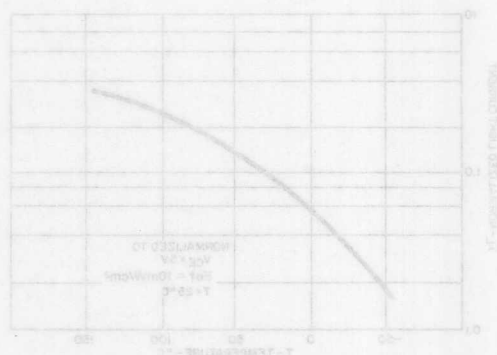


Fig. 3. Normalized Light Current vs. Temperature

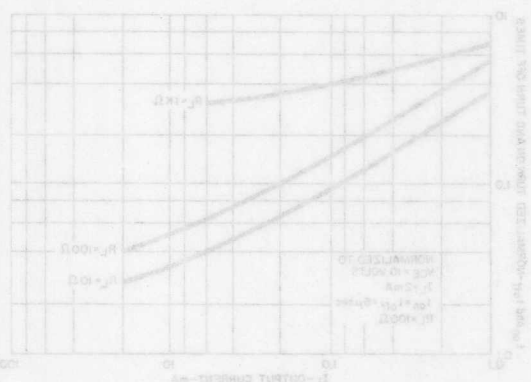


Fig. 4. Switching Time vs. Output Current

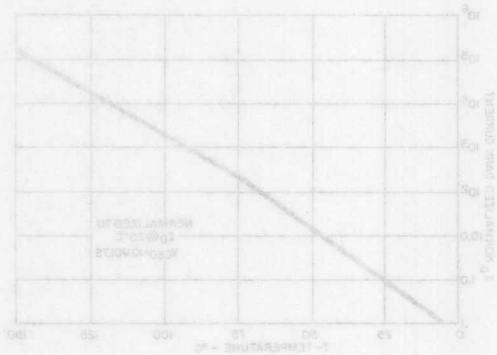


Fig. 5. Dark Current vs. Temperature

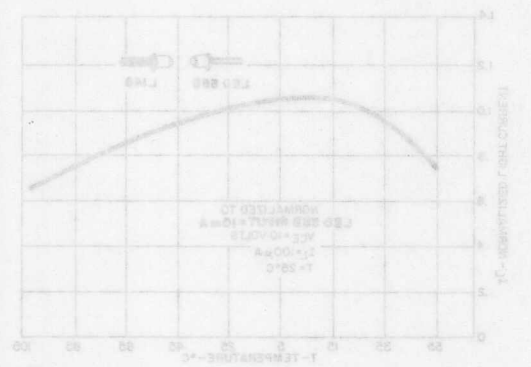
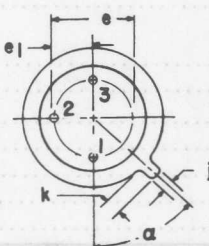
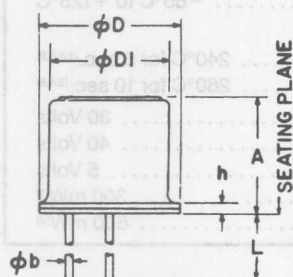


Fig. 6. Normalized Light Current vs. Temperature
Both Emitter (LEDs) and Detector
(L-4C) at Same Temperature

PACKAGE DIMENSIONS



ST1336

DESCRIPTION

The L14N series is a silicon phototransistor mounted in a wide angle, TO-18 package.

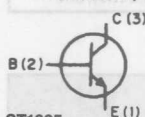
FEATURES

- Hermetically sealed package.
- Narrow reception angle.
- Device can be used as a photodiode by using the collector and base leads.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	—	.210	—	5.34	
ϕb	.016	.021	.406	.534	
ϕD	.209	.230	5.30	5.85	
ϕDI	.178	.195	4.52	4.96	
e	.100	NOM	2.54	NOM	2
e ₁	0.50	NOM	1.27	NOM	2
h	—	.030	—	.76	
j	.036	.046	.91	1.17	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
α	45°	45°	45°	45°	3

PACKAGE OUTLINE

(COLLECTOR
CONNECTED
TO CASE)



ST1605

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	−65°C to +150°C
Operating Temperature	−65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Collector-Emitter Breakdown Voltage	30 Volts
Collector-Base Breakdown Voltage	40 Volts
Emitter-Base Breakdown Voltage	5 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	5	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	40	—	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$, $E_e = 0$
Collector-Base Leakage	I_{CBO}	—	—	25	nA	$V_{CB} = 25\text{ V}$, $E_e = 0$
Reception Angle at ½ Sensitivity	θ	—	±40	—	Degrees	
On-State Collector Current L14N1	$I_{C(ON)}$	3.0	—	—	mA	$E_e = 1.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Collector Current L14N2	$I_{C(ON)}$	6.0	—	—	mA	$E_e = 1.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Photodiode Current	$I_{CB(ON)}$	—	5.0	—	μA	$E_e = 1.5\text{ mW/cm}^2$, $V_{CB} = 5\text{ V}$
Rise Time	t_r	—	14	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	16	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Saturation Voltage L14N1	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.8\text{ mA}$, $E_e = 3.0\text{ mW/cm}^2$ ^(7,8)
Saturation Voltage L14N2	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 1.6\text{ mA}$, $E_e = 3.0\text{ mW/cm}^2$ ^(7,8)

NOTES

1. Derate power dissipation linearly 3.00mW/°C above 25°C ambient.
2. Derate power dissipation linearly 6.00mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
8. Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 10 mW/cm².

TYPICAL CHARACTERISTICS

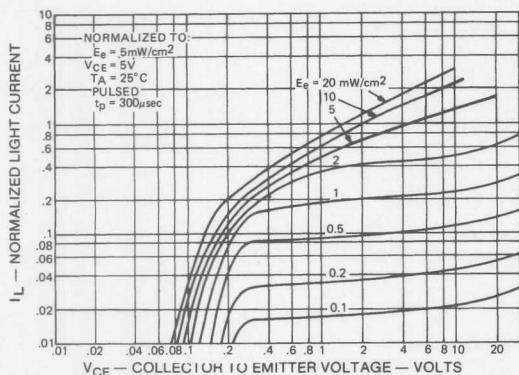


Fig. 1. Light Current vs. Collector to Emitter Voltage ST1092

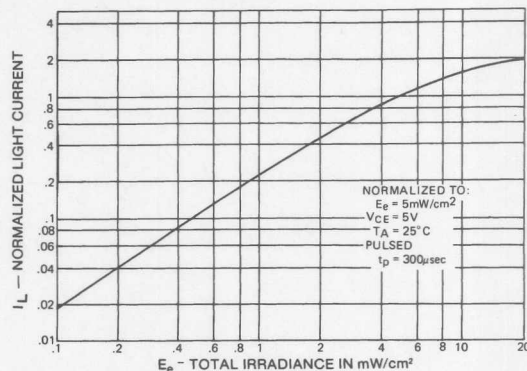


Fig. 2. Light Current vs. Radiation ST1097

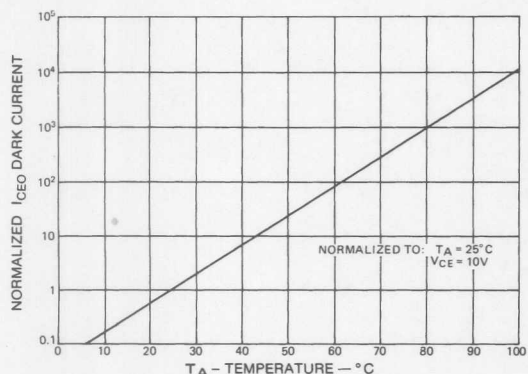


Fig. 3. Dark Current vs. Temperature ST1093

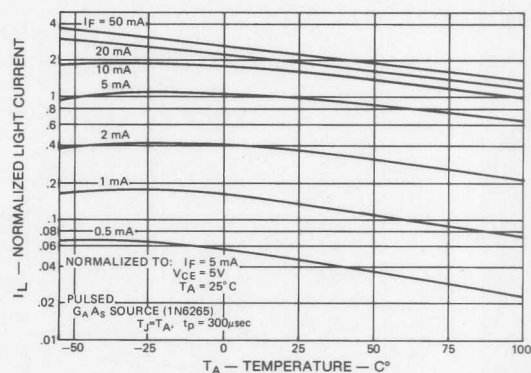


Fig. 4. Light Current vs. Temperature ST1096

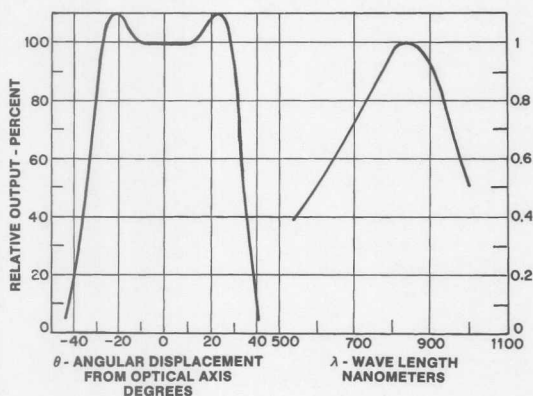


Fig. 5. Angular and Spectral Response ST1094

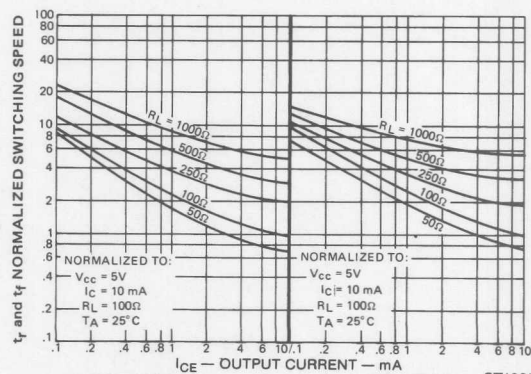
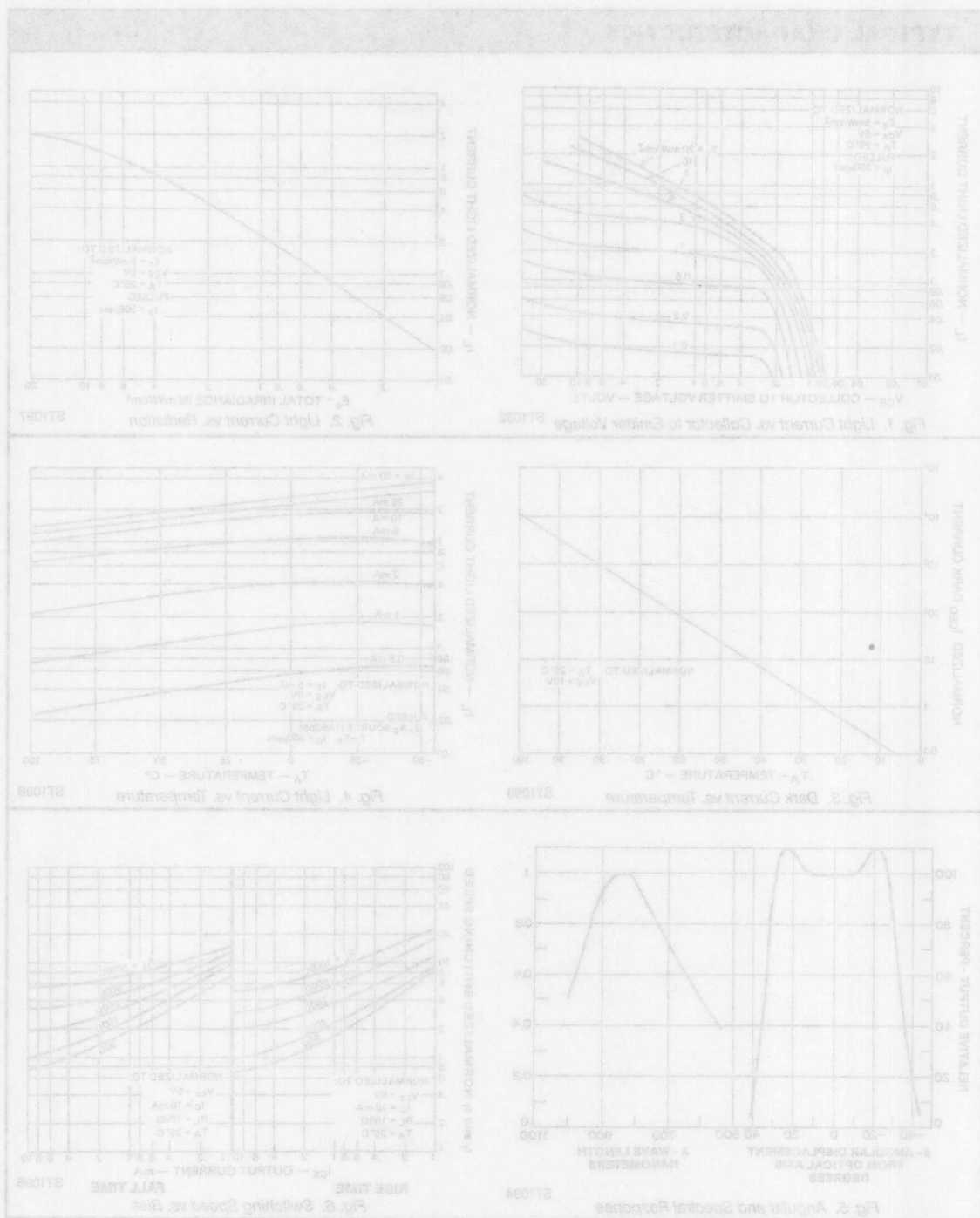
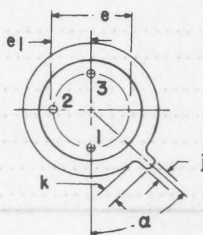
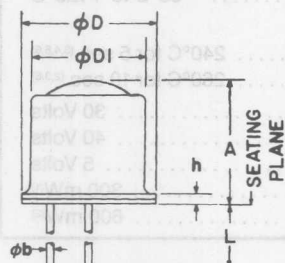


Fig. 6. Switching Speed vs. Bias ST1095



PACKAGE DIMENSIONS



ST1333

DESCRIPTION

The L14P series is a silicon phototransistor mounted in a narrow angle, TO-18 package.

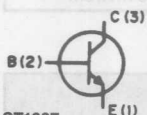
FEATURES

- Hermetically sealed package
- Narrow reception angle
- Devices can be used as a photodiode by wiring the collector and base leads.

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.225	.255	5.71	6.47	
ϕb	.016	.021	.407	.533	
ϕD	.209	.230	5.31	5.84	
ϕD ₁	.178	.195	4.52	4.96	
e	100 NOM		2.54 NOM		2
e ₁	.050 NOM		1.27 NOM		2
h	—	.030	—	.76	
j	.036	.046	.92	1.16	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
α	45°	45°	45°	45°	3

PACKAGE OUTLINE

(COLLECTOR
CONNECTED
TO CASE)



ST1607

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,6)
Collector-Emitter Breakdown Voltage	30 Volts
Collector-Base Breakdown Voltage	40 Volts
Emitter-Base Breakdown Voltage	5 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	40	—	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$, $E_e = 0$
Collector-Base Leakage	I_{CBO}	—	—	25	nA	$V_{CB} = 25\text{ V}$, $E_e = 0$
Reception Angle at ½ Sensitivity	θ	—	± 12	—	Degrees	
On-State Collector Current L14P1	$I_{C(ON)}$	4.0	—	—	mA	$E_e = 0.3\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Collector Current L14P2	$I_{C(ON)}$	8.0	—	—	mA	$E_e = 0.3\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
On-State Photodiode Current	$I_{CB(ON)}$	—	6.0	—	μA	$E_e = 0.3\text{ mW/cm}^2$, $V_{CB} = 5\text{ V}$
Rise Time	t_r	—	10	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	12	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 100\Omega$
Saturation Voltage L14P1	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 0.8\text{ mA}$, $E_e = .6\text{ mW/cm}^2$ ^(7,8)
Saturation Voltage L14P2	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 1.6\text{ mA}$, $E_e = .6\text{ mW/cm}^2$ ^(7,8)

NOTES

- Derate power dissipation linearly 3.00mW/°C above 25°C ambient.
- Derate power dissipation linearly 6.00mW/°C above 25°C case.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip 1/16" (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
- Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 10 mW/cm².

TYPICAL CHARACTERISTICS

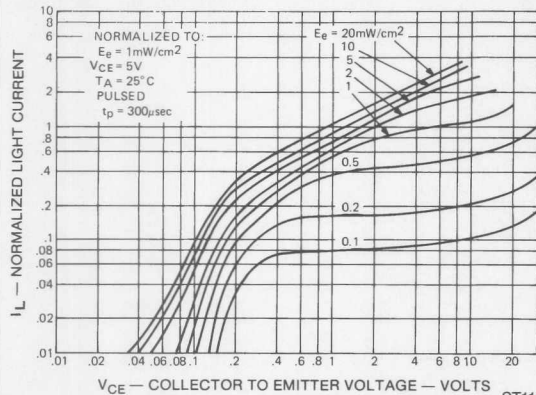


Fig. 1. Light Current vs. Collector to Emitter Voltage ST1102

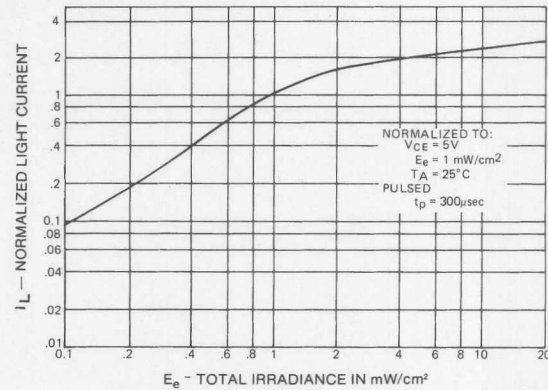


Fig. 2. Light Current vs. Radiation ST1107

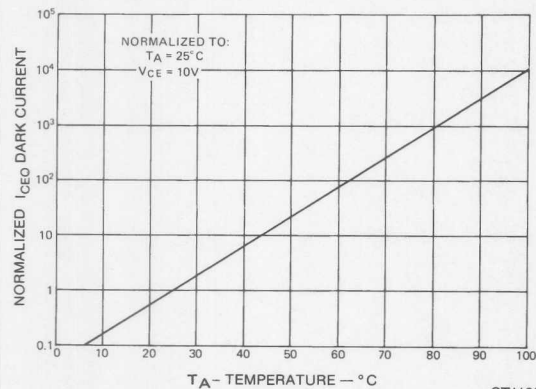


Fig. 3. Dark Current vs. Temperature ST1103

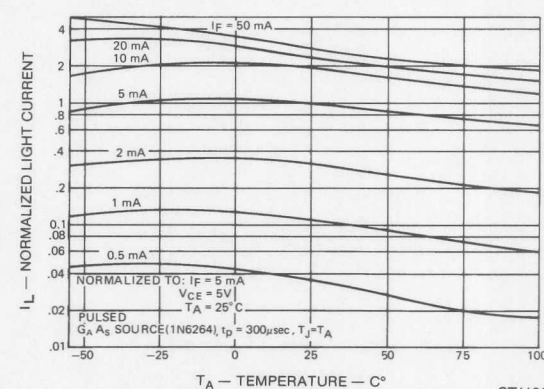


Fig. 4. Light Current vs. Temperature ST1106

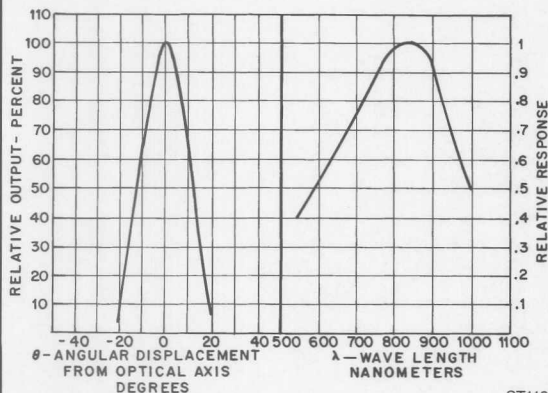


Fig. 5. Angular and Spectral Response ST1104

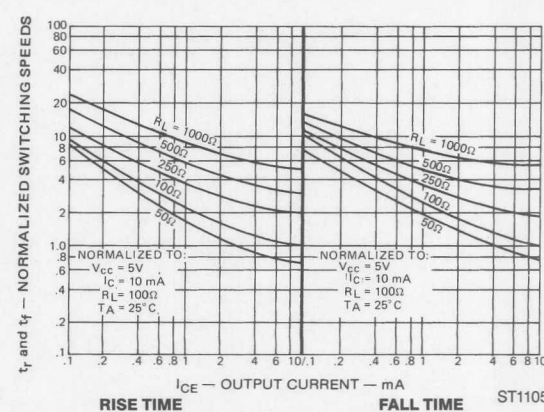
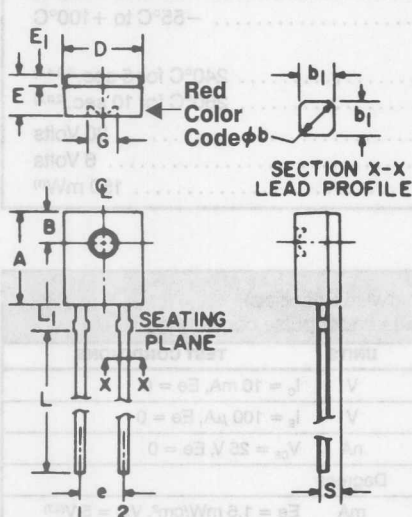


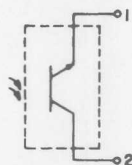
Fig. 6. Switching Speed vs. Bias ST1105

PACKAGE DIMENSIONS



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
ϕb	.60	.75	.024	.030	1
b ₁	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E ₁	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L ₁	1.40	1.65	.055	.065	
S	.83	.94	.033	.037	3

PACKAGE OUTLINE



ST1608

NOTES:

1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27mm (.050") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

DESCRIPTION

The L14Q1 is a silicon phototransistor encapsulated in a clear, wide angle, sidelooker package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the F5F LED
- Plastic package with a color stripe for easy recognition from LED

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	6 Volts
Power Dissipation	150 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Collector Breakdown	BV_{ECO}	6.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 25\text{ V}$, $E_e = 0$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 35	—	Degrees	
On-State Collector Current	$I_{C(ON)}$	1.0	—	—	mA	$E_e = 1.5\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(6,7)
Turn-On Time	t_{on}	—	8	—	μS	$I_F = 30\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 2.5\text{ K}\Omega$
Turn-Off Time	t_{off}	—	50	—	μS	$I_C = 30\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 2.5\text{ K}\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = .5\text{ mA}$, $E_e = .60\text{ mW/cm}^2$ ^(6,7)

NOTES

1. Derate power dissipation linearly $2.00\text{ mW}/^\circ\text{C}$ above 25°C ambient.
2. RMA flux is recommended.
3. Methanol or Isopropyl alcohols are recommended as cleaning agents.
4. Soldering iron tip $\frac{1}{16}"$ (1.6 mm) minimum from housing.
5. As long as leads are not under any stress or spring tension.
6. Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
7. Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm^2 is approximately equivalent to a tungsten source, at 2870°K , of 10 mW/cm^2 .



- NOTES:
1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27 mm ($.050"$) OF SEATING PLANE.
 2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN $.25\text{ mm}$ ($.010"$) OF TRUE POSITION.
 3. AS MEASURED AT THE SEATING PLANE.
 4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

TYPICAL CHARACTERISTICS

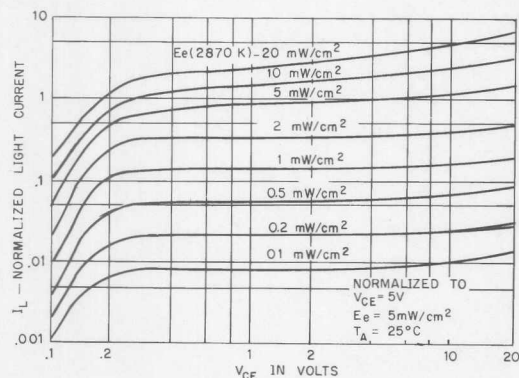


Fig. 1. Light Current vs. Collector to Emitter Voltage ST1110-11

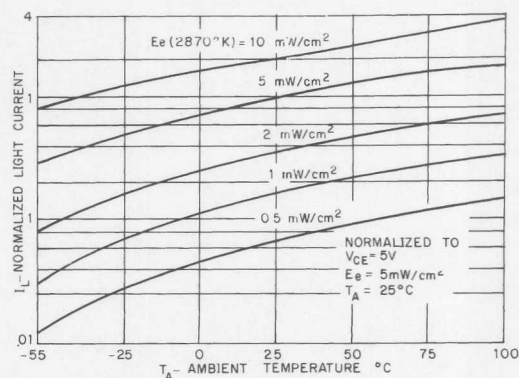


Fig. 2. Light Current vs. Ambient Temperature ST1113-11

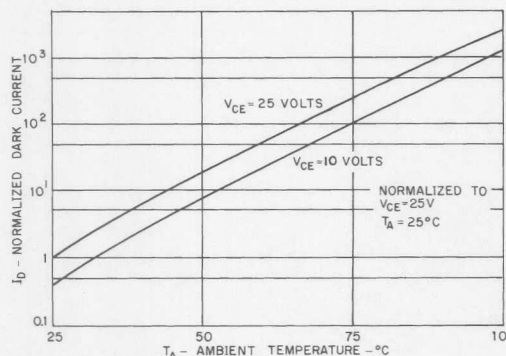


Fig. 3. Leakage Current vs. Temperature ST1111-11

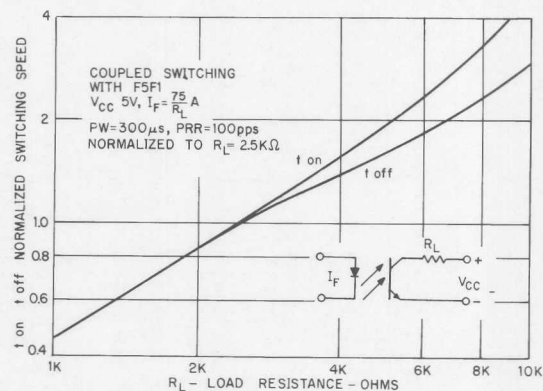


Fig. 4. Switching Time vs. Load Resistance ST1114-11

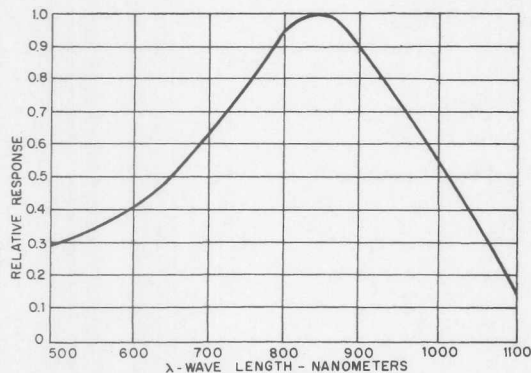


Fig. 5. Spectral Response ST1112-11

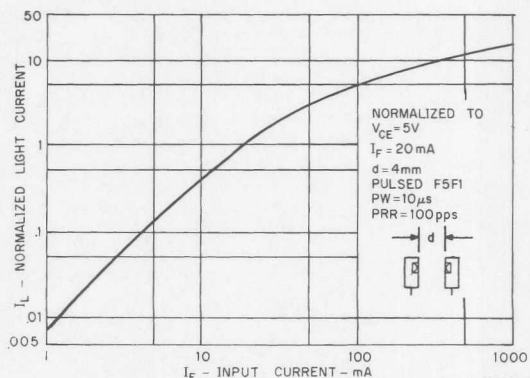


Fig. 6. Coupled Light Current vs. F5F1 Input Current ST1115-11

TYPICAL CHARACTERISTICS

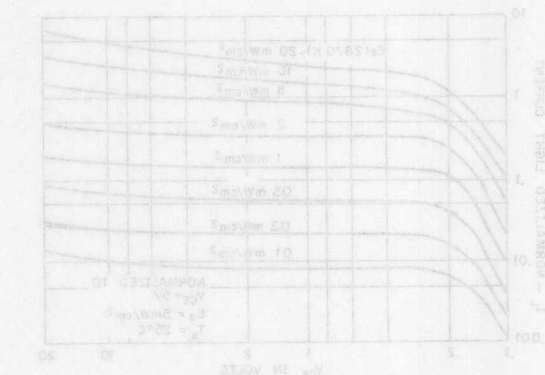
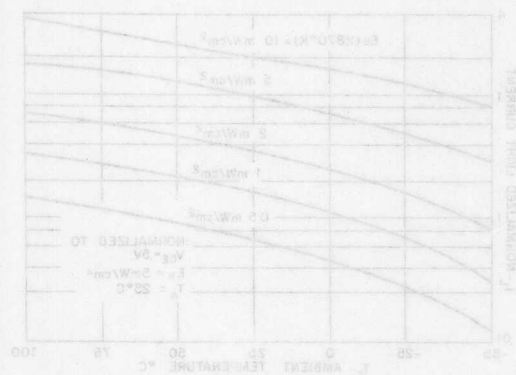


Fig. 1 Light Current vs. Collector to Emitter Voltage

Fig. 2 Light Current vs. Ambient Temperature

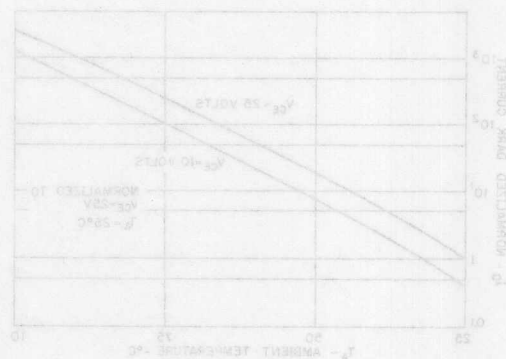


Fig. 3 Switching Time vs. Load Resistance

Fig. 4 Leakage Current vs. Temperature

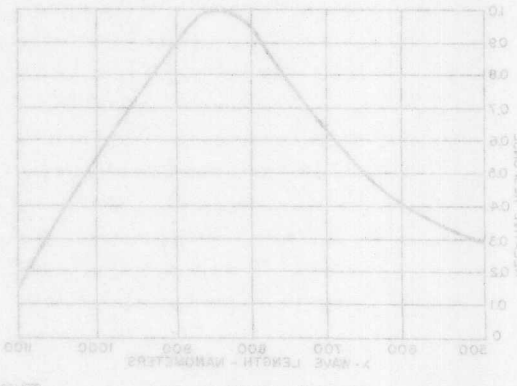
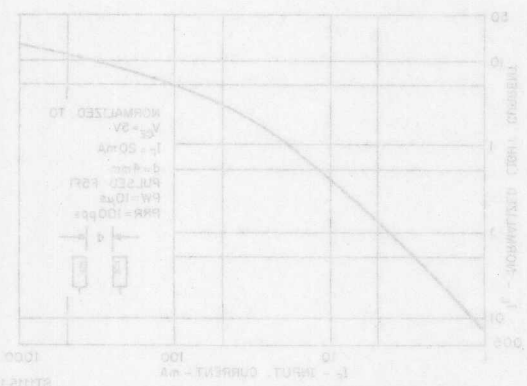
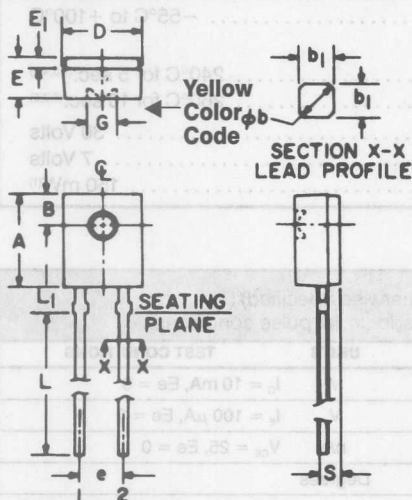


Fig. 5 Spectral Response

Fig. 6 Coupled Light Current vs. FET Input Current

PACKAGE DIMENSIONS



DESCRIPTION

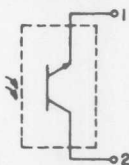
The L14R1 is a silicon photodarlington encapsulated in a clear, wide angle, sidelooper package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the F5F LED
- Plastic package with a color stripe for easy recognition from LED

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
φb	.60	.75	.024	.030	1
b ₁	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E ₁	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L ₁	1.40	1.65	.055	.065	
S	.83	.94	.033	.037	3

PACKAGE OUTLINE



ST1608

NOTES:

1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27mm (.050") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to +100°C
Operating Temperature	-55°C to +100°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(2,3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(2,3,5)
Collector-Emitter Breakdown Voltage	30 Volts
Emitter-Collector Breakdown Voltage	7 Volts
Power Dissipation	150 mW ⁽¹⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Collector Breakdown	BV_{ECO}	7.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 25$, $E_e = 0$
Reception Angle at ½ Sensitivity	θ	—	± 35	—	Degrees	
On-State Collector Current	$I_{C(ON)}$	5.0	—	—	mA	$E_e = 0.3\text{ mW/cm}^2$, $V_{CE} = 1.5\text{ V}$ ^(6,7)
Turn-On Time	t_{on}	—	45	—	μS	$I_F = 10\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 750\Omega$
Turn-Off Time	t_{off}	—	250	—	μS	$I_F = 10\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 750\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	1.2	V	$I_C = 20\text{ mA}$, $E_e = .60\text{ mW/cm}^2$ ^(6,7)

NOTES

- Derate power dissipation linearly 2.00mW/°C above 25°C ambient.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip 1/16" (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
- Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 10 mW/cm².

TYPICAL CHARACTERISTICS

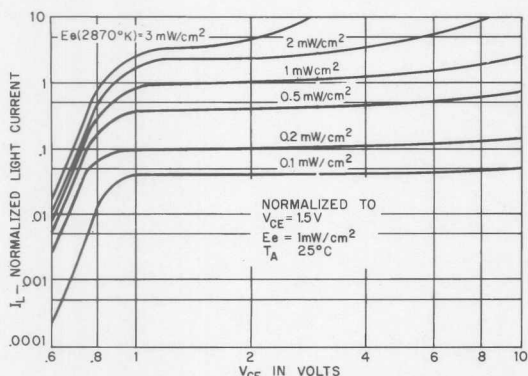


Fig. 1. Light Current vs. Collector-Emitter Voltage

ST1118-11

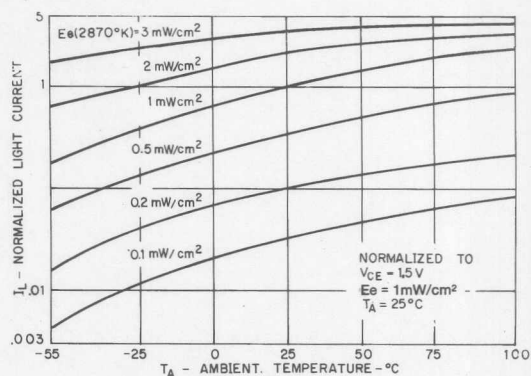


Fig. 2. Light Current vs. Ambient Temperature

ST1123-11

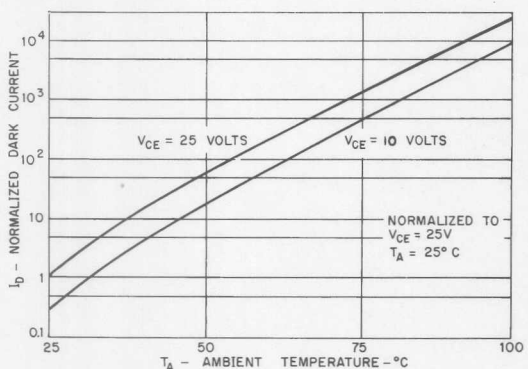


Fig. 3. Leakage Current vs. Temperature

ST1119-11

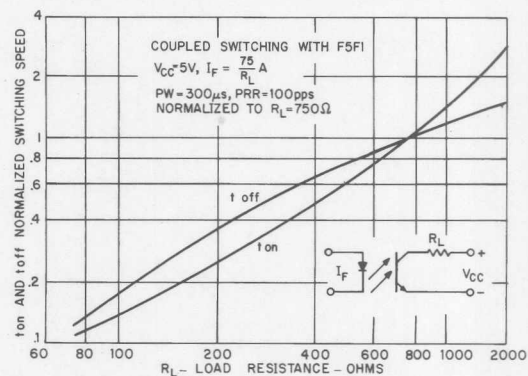


Fig. 4. Switching Time vs. Load Resistance

ST1122-11

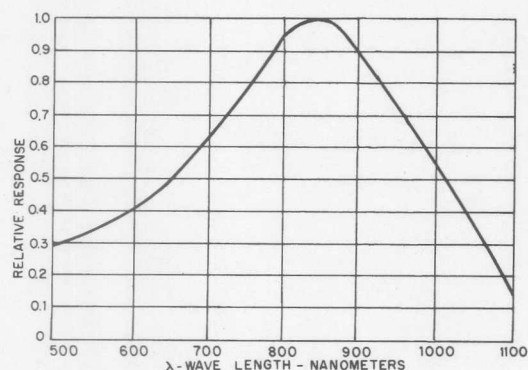


Fig. 5. Spectral Response

ST1120-11

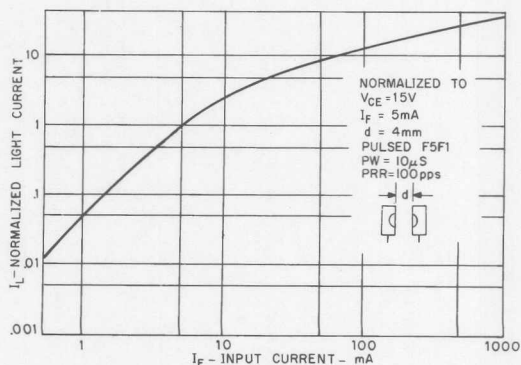
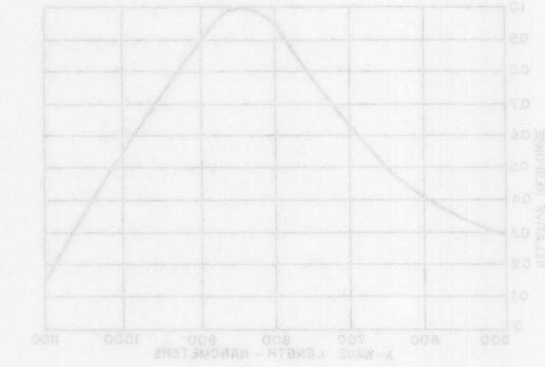
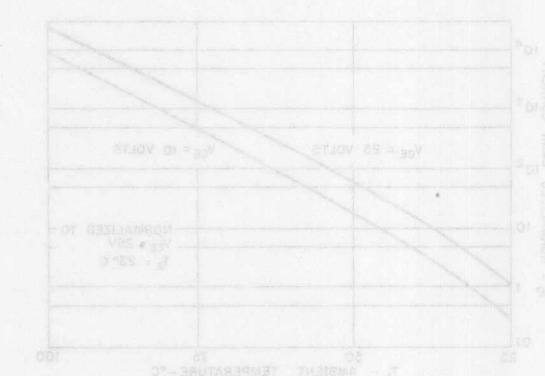
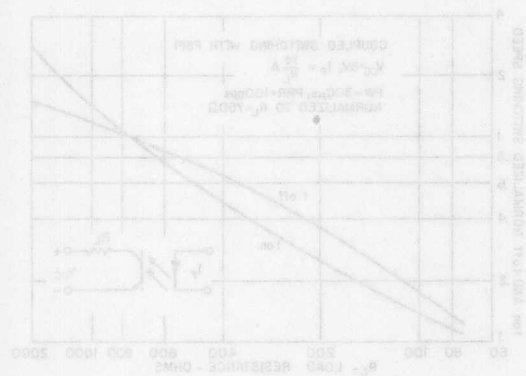
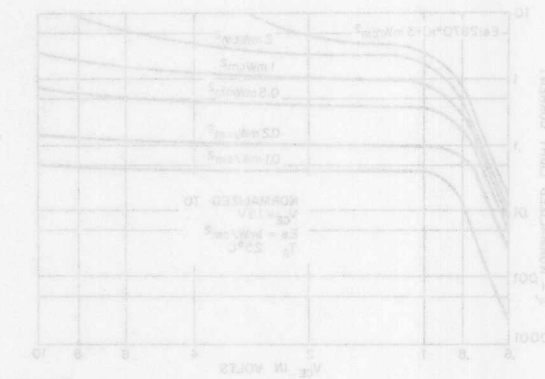
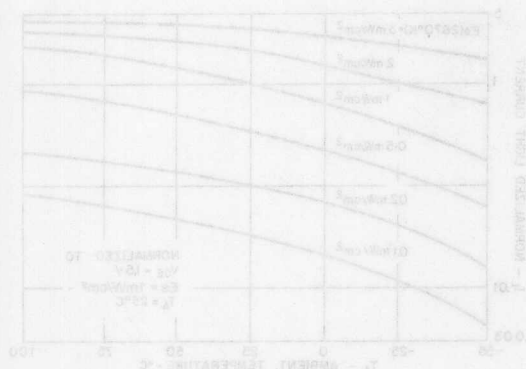
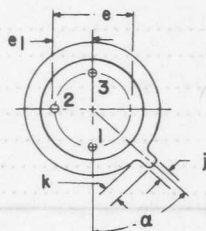
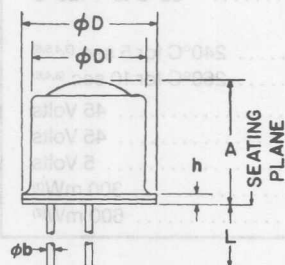


Fig. 6. Coupled Light Current vs. F5F1 Input Current

ST1121-11



PACKAGE DIMENSIONS



ST1333

DESCRIPTION

The BPW36/37 are silicon phototransistors mounted in narrow angle TO-18 packages.

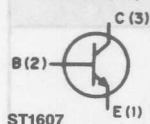
FEATURES

- Hermetically sealed package
- Narrow reception angle
- European "Pro Electron" registered

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.225	.255	5.71	6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi DI	.178	.195	4.52	4.96	
e	.100 NOM		2.54 NOM		2
e1	.050 NOM		1.27 NOM		2
h	—	.030	—	.76	
j	.036	.046	.92	1.16	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
alpha	45°	45°	45°	45°	3

PACKAGE OUTLINE

(COLLECTOR
CONNECTED
TO CASE)



ST1607

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (137 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Collector-Emitter Breakdown Voltage	45 Volts
Collector-Base Breakdown Voltage	45 Volts
Emitter-Base Breakdown Voltage	5 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	45	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	5.0	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	45	—	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 10\text{ V}$, $E_e = 0$
Reception Angle at ½ Sensitivity	θ	—	± 10	—	Degrees	
On-State Collector Current BPW36	$I_{C(ON)}$	6.0	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁷⁾
On-State Collector Current BPW37	$I_{C(ON)}$	3.0	—	—	mA	$E_e = 3.0\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ⁽⁷⁾
Turn-On Time	t_{on}	—	8	—	μS	$I_C = 2\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Turn-Off Time	t_{off}	—	7	—	μS	$I_C = 2\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Saturation Voltage	$V_{CE(SAT)}$	—	—	0.40	V	$I_C = 1.0\text{ mA}$, $E_e = 3.0\text{ mW/cm}^2$ ⁽⁷⁾

NOTES

1. Derate power dissipation linearly 3.00mW/°C above 25°C ambient.
2. Derate power dissipation linearly 6.00mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
8. Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 3.0 mW/cm² is approximately equivalent to a tungsten source, at 2870°K, of 10 mW/cm².

TYPICAL CHARACTERISTICS

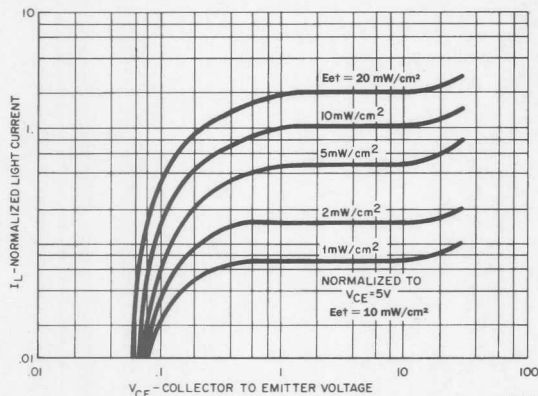


Fig. 1. Light Current vs. Collector to Emitter Voltage

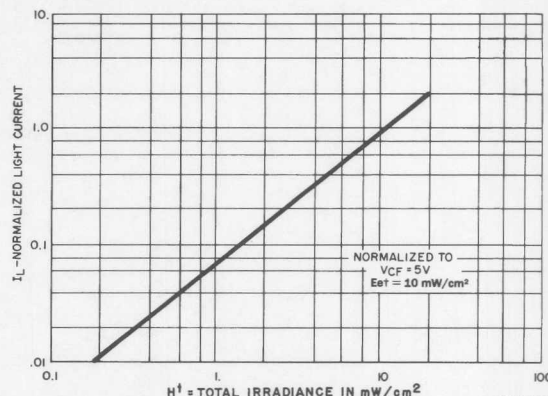


Fig. 2. Normalized Light Current vs. Radiation

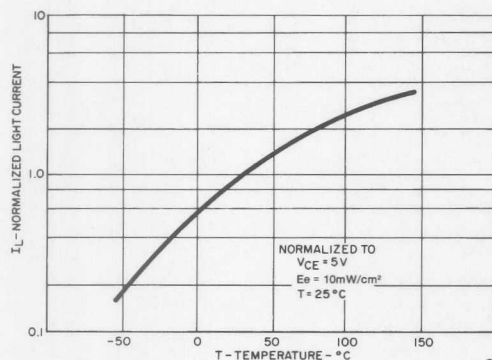


Fig. 3. Normalized Light Current vs. Temperature

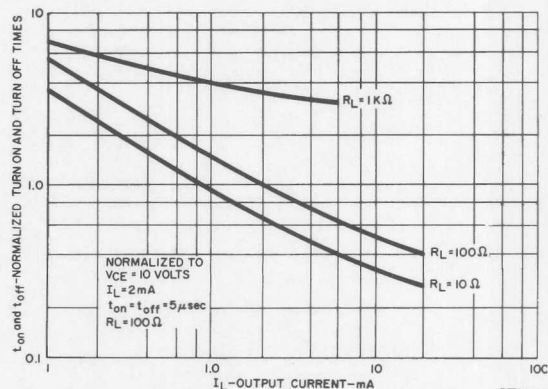


Fig. 4. Switching Times vs. Output Current

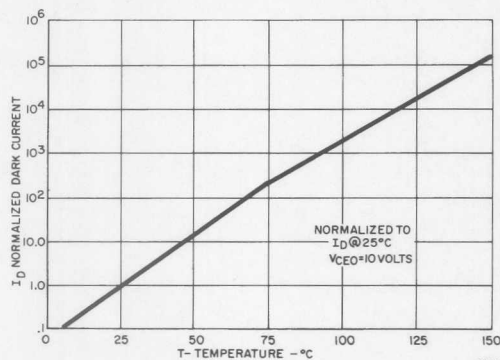


Fig. 5. Dark Current vs. Temperature

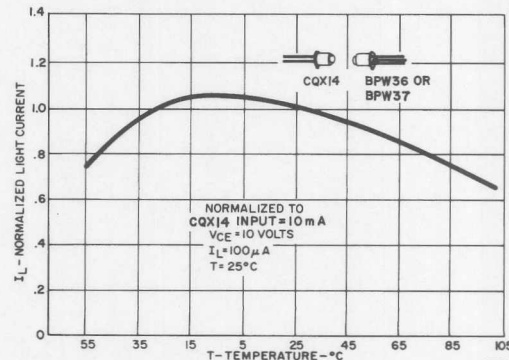


Fig. 6. Normalized Light Current vs. Temperature Both Emitter (CQX14) and Detector (BPW36 or BPW37) at Same Temperature

TYPICAL CHARACTERISTICS

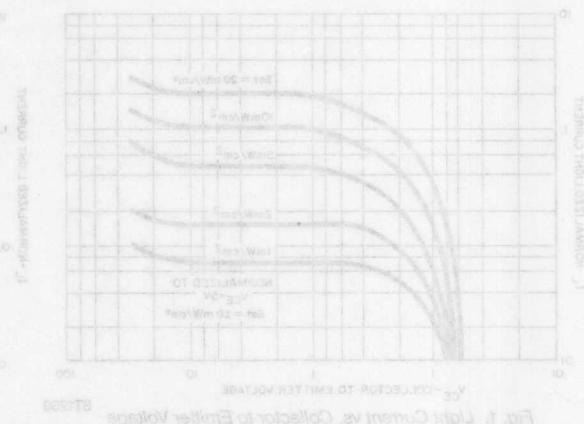


Fig. 1. Light Current vs. Collector to Emitter Voltage



Fig. 2. Normalized Light Current vs. Radiation

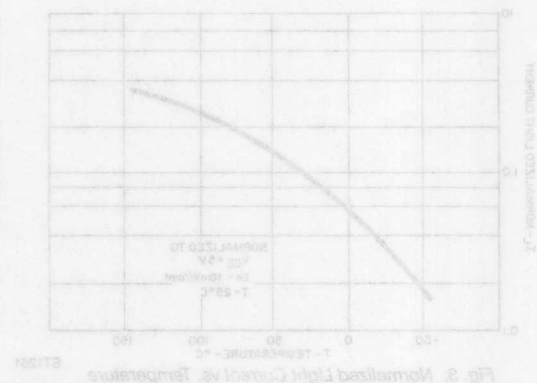


Fig. 3. Normalized Light Current vs. Temperature

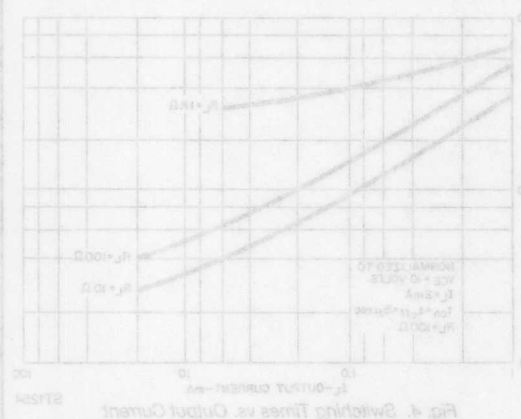


Fig. 4. Switching Times vs. Output Current

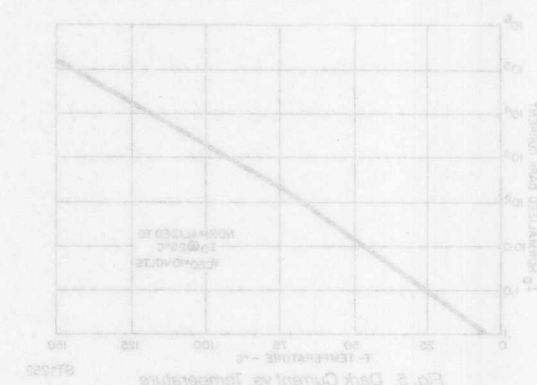


Fig. 5. Dark Current vs. Temperature

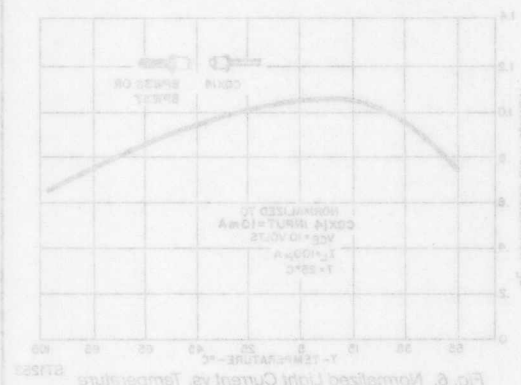
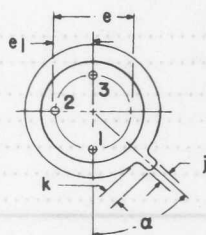
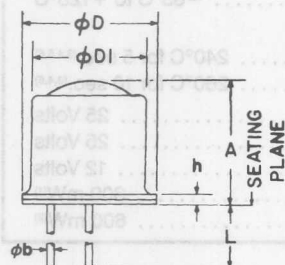


Fig. 6. Normalized Light Current vs. Temperature
Both Emitter (COX4) and Detector
(BPW37) at Same Temperature

PACKAGE DIMENSIONS



ST1333

DESCRIPTION

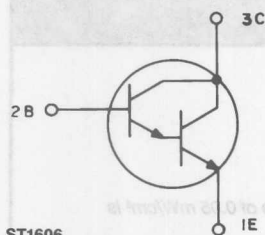
The BPW38 is a silicon photodarlington mounted in a narrow angle TO-18 package.

FEATURES

- Hermetically sealed package
- Narrow reception angle
- European "Pro Electron" registered

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	.225	.255	5.71	6.47	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi DI	.178	.195	4.52	4.96	
e	.100	NOM	2.54	NOM	2
e1	.050	NOM	1.27	NOM	2
h	—	.030	—	.76	
j	.036	.046	.92	1.16	
k	.028	.048	.71	1.22	1
L	.500	—	12.7	—	
alpha	45°	45°	45°	45°	3

PACKAGE OUTLINE



ST1606

NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

BPW38

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to $+150^\circ\text{C}$
Operating Temperature	-65°C to $+125^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Collector-Emitter Breakdown Voltage	25 Volts
Collector-Base Breakdown Voltage	25 Volts
Emitter-Base Breakdown Voltage	12 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	300 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	600 mW ⁽²⁾

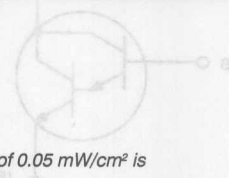
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Collector-Emitter Breakdown	BV_{CEO}	25	—	—	V	$I_C = 10\text{ mA}$, $E_e = 0$
Emitter-Base Breakdown	BV_{EBO}	12	—	—	V	$I_E = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Base Breakdown	BV_{CBO}	25	—	—	V	$I_C = 100\text{ }\mu\text{A}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	—	100	nA	$V_{CE} = 12\text{ V}$, $E_e = 0$
Reception Angle at $\frac{1}{2}$ Sensitivity	θ	—	± 8	—	Degrees	
On-State Collector Current	$I_{C(ON)}$	3.0	—	—	mA	$E_e = .05\text{ mW/cm}^2$, $V_{CE} = 5\text{ V}$ ^(7,8)
Rise Time	t_r	—	300	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$
Fall Time	t_f	—	250	—	μS	$I_C = 10\text{ mA}$, $V_{CC} = 10\text{ V}$, $R_L = 100\Omega$

NOTES

- Derate power dissipation linearly $3.00\text{ mW}/^\circ\text{C}$ above 25°C ambient.
- Derate power dissipation linearly $6.00\text{ mW}/^\circ\text{C}$ above 25°C case.
- RMA flux is recommended.
- Methanol or Isopropyl alcohols are recommended as cleaning agents.
- Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
- As long as leads are not under any stress or spring tension.
- Light source is a GaAs LED emitting light at a peak wavelength of 940 nm.
- Figure 1 and figure 2 use light source of tungsten lamp at 2870°K color temperature. A GaAs source of 0.05 mW/cm^2 is approximately equivalent to a tungsten source, at 2870°K , of 0.2 mW/cm^2 .



TYPICAL CHARACTERISTICS

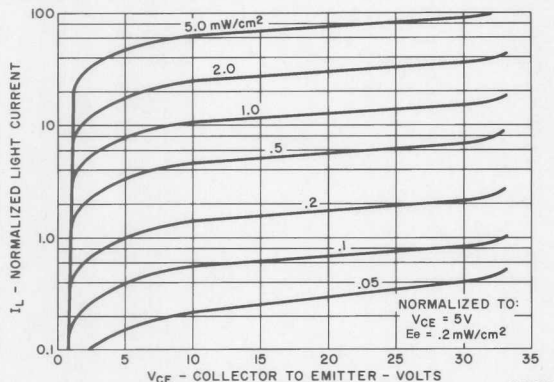


Fig. 1. Light Current vs. Collector to Emitter Voltage

ST1260

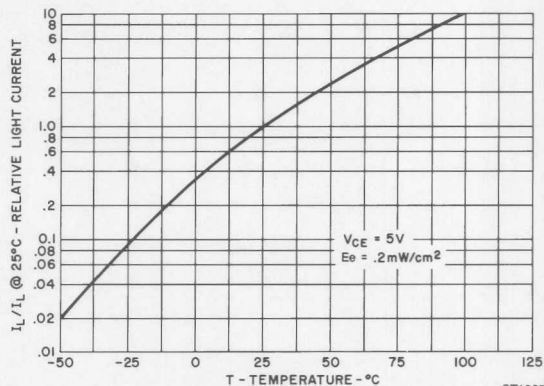


Fig. 2. Relative Light Current vs. Ambient Temperature

ST1265

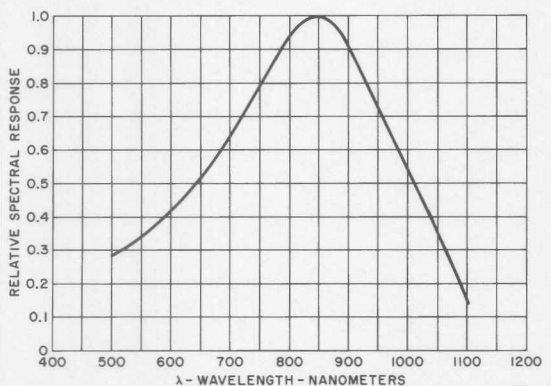


Fig. 3. Spectral Response Curve

ST1261

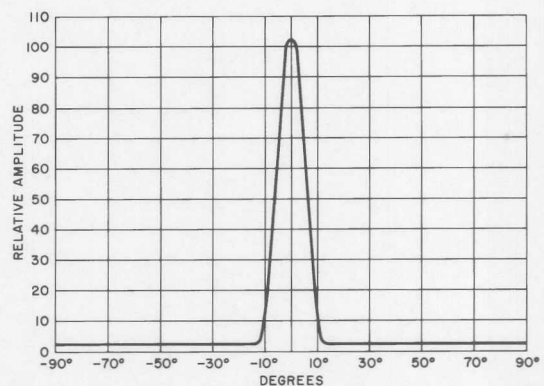


Fig. 4. Angular Response

ST1264

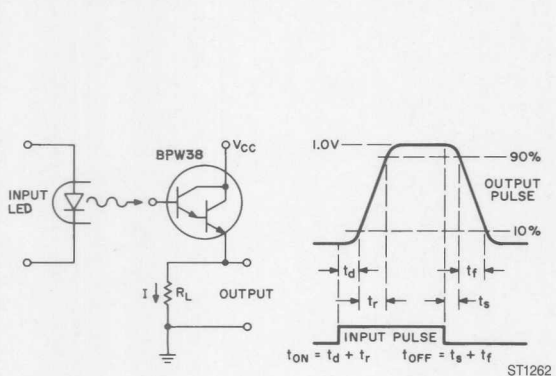


Fig. 5. Test Circuit and Voltage Waveforms

ST1262

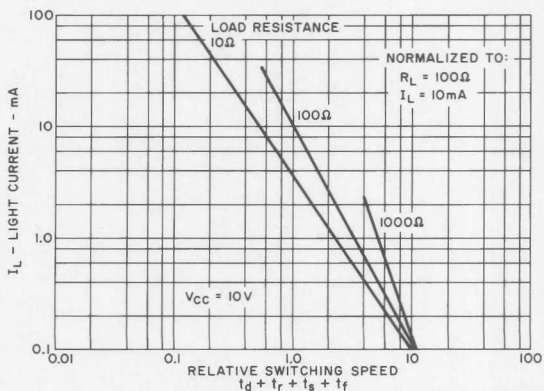


Fig. 6. Light Current vs. Relative Switching Speed

ST1263

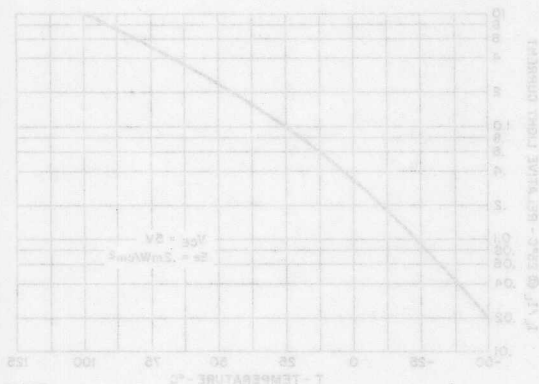


Fig. 2. Relative Light Current vs. Ambient Temperature

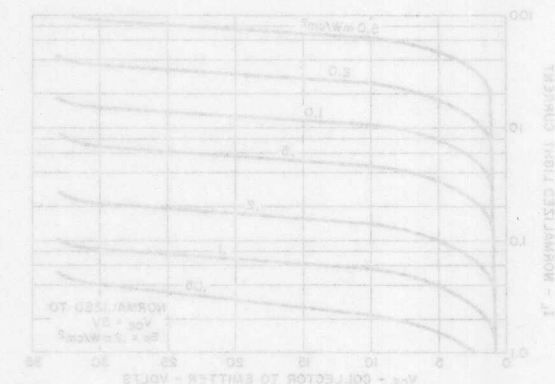


Fig. 1. Light Current vs. Collector to Emitter Voltage

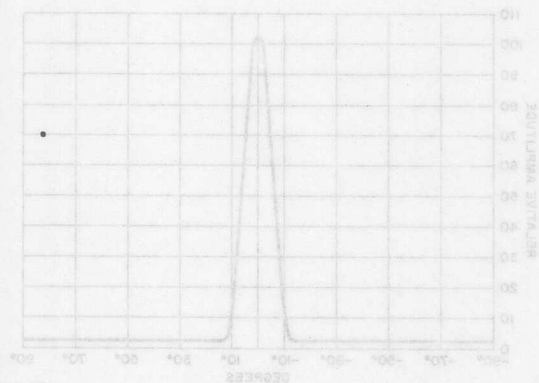


Fig. 4. Angular Response

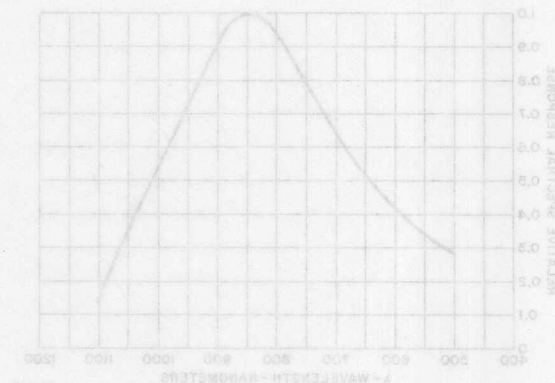


Fig. 3. Spectral Response Curve

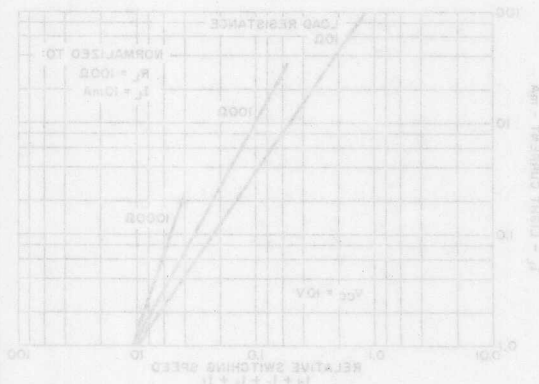


Fig. 5. Light Current vs. Relative Switching Speed

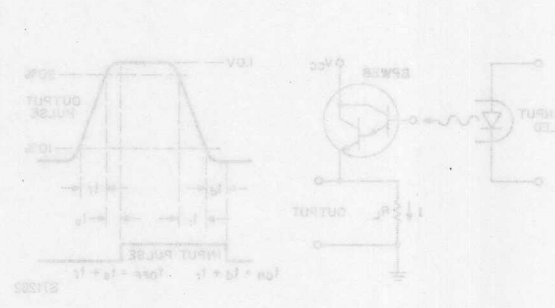
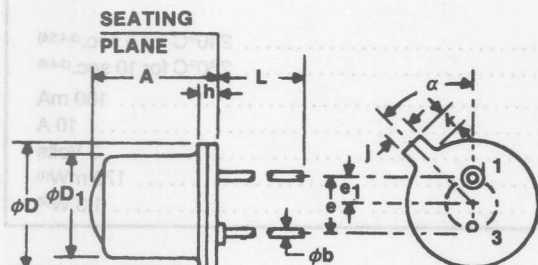


Fig. 6. Test Circuit and Voltage Waveforms

CQX14, CQX16

3

PACKAGE DIMENSIONS



ST1332

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.255		6.47	
ϕb	.016	.021	.407	.533	
ϕD	.209	.230	5.31	5.84	
ϕD_1	.180	.187	4.52	4.77	
e	.100	NOM.	2.54	NOM.	2
e ₁	.050	NOM.	1.27	NOM.	2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
α	45°	45°	45°	45°	3

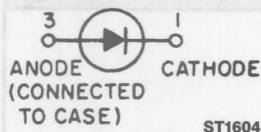
DESCRIPTION

The CQX14/16 are 940nm LEDs in narrow angle, TO-46 packages.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 phototransistor
- Hermetically sealed package
- High irradiance level
- European "Pro Electron" registered

PACKAGE OUTLINE



NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Continuous Forward Current	100 mA
Forward Current (pw, 1 μs ; 200 Hz)	10 A
Reverse Voltage	3 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 100 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
Peak Emission Wavelength	λ_P		940		nm	$I_F = 100 \text{ mA}$
Emission Angle at $\frac{1}{2}$ Power	θ		± 8		Degrees	
Total Power CQX14	P_O	5.4		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Total Power CQX16	P_O	1.5		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r		1.0		μs	
Fall Time 100-10% of output	t_f		1.0		μs	

NOTES

1. Derate power dissipation linearly 1.70mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_O , is the total power radiated by the device into a solid angle of 2π steradians.

TYPICAL CHARACTERISTICS

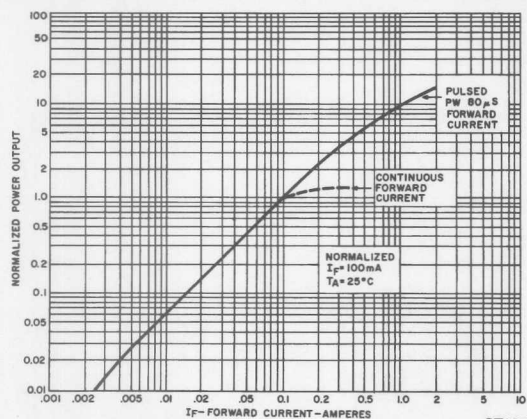


Fig. 1. Power Output vs. Input Current ST1271

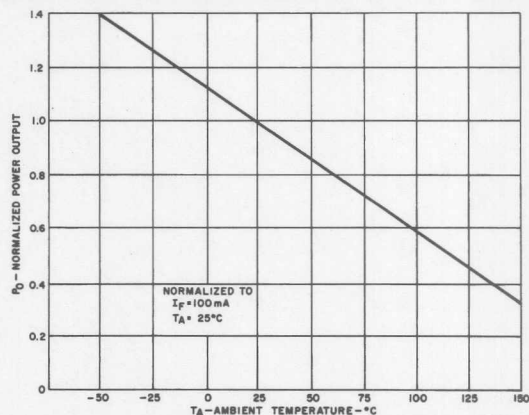


Fig. 2. Power Output vs. Temperature ST1276

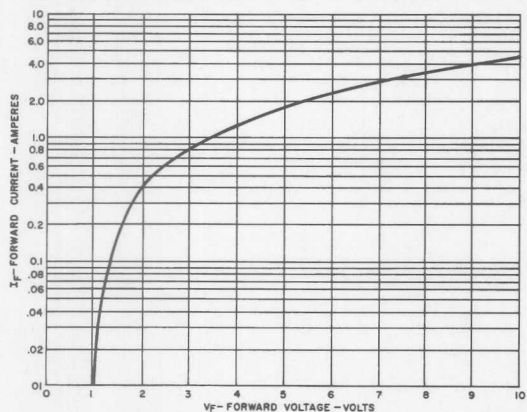


Fig. 3. Forward Voltage vs. Forward Current ST1272

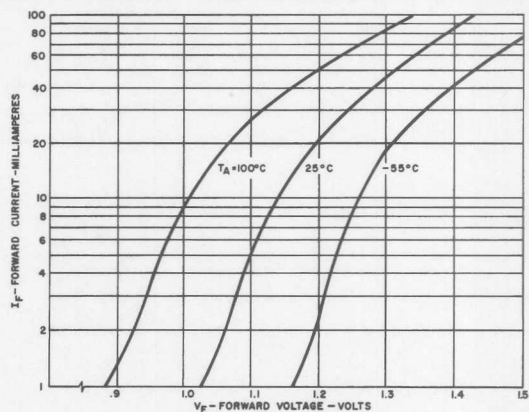


Fig. 4. Forward Voltage vs. Forward Current ST1275

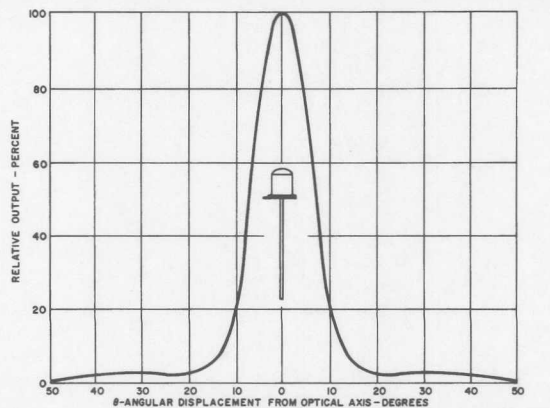


Fig. 5. Typical Radiation Pattern ST1273

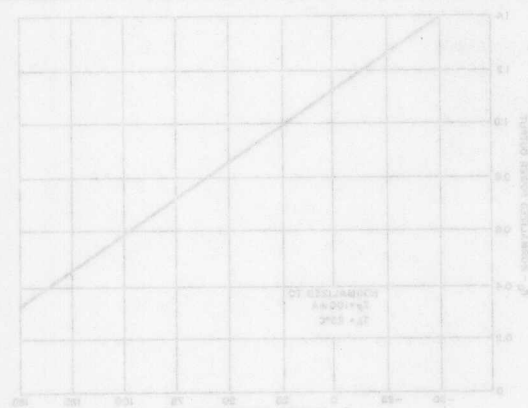


Fig. 2 Power Output vs. Temperature



Fig. 1 Power Output vs. Forward Current

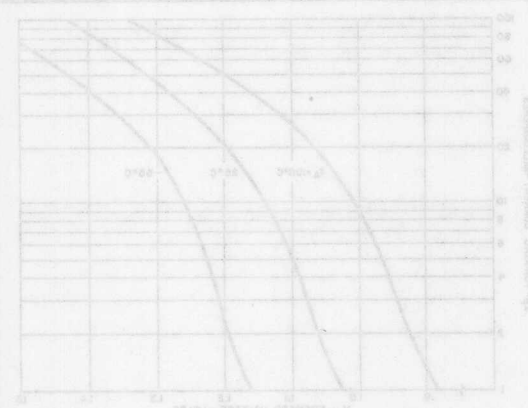


Fig. 4 Forward Voltage vs. Forward Current

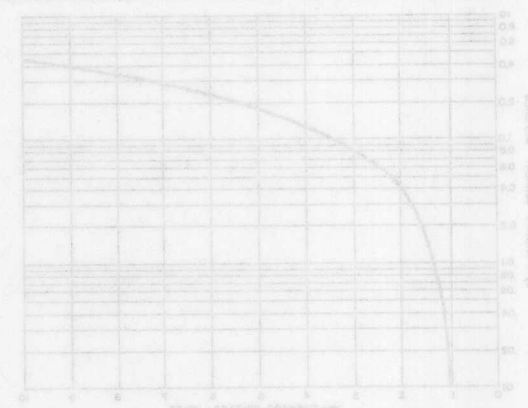


Fig. 3 Forward Voltage vs. Forward Current

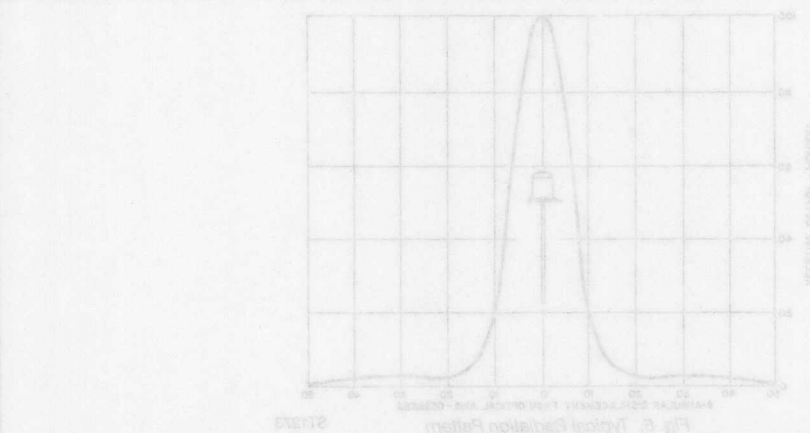
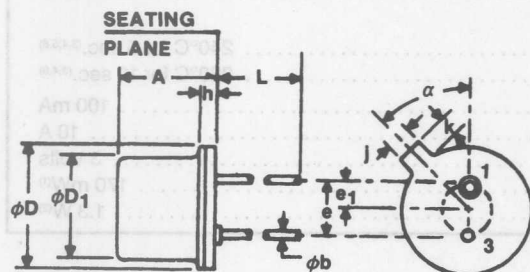


Fig. 5 Typical Radiation Pattern

CQX15, CQX17

PACKAGE DIMENSIONS



ST1331

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN.	MAX.	MIN.	MAX.	
A		.155		3.93	
phi b	.016	.021	.407	.533	
phi D	.209	.230	5.31	5.84	
phi D1	.180	.187	4.57	4.77	
e	.100 NOM.		2.54 NOM.		2
e1	.050 NOM.		1.27 NOM.		2
h		.030		.76	
j	.031	.044	.79	1.11	
k	.036	.046	.92	1.16	1
L	1.00		25.4		
alpha	45°	45°	45°	45°	3

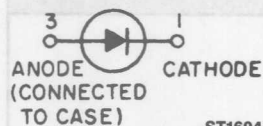
DESCRIPTION

The CQX15/17 are 940nm LEDs in wide angle, TO-46 packages.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to TO-18 phototransistor
- Hermetically sealed package
- High irradiance level
- European "Pro Electron" registered

PACKAGE OUTLINE



NOTES:

1. MEASURED FROM MAXIMUM DIAMETER OF DEVICE.
2. LEADS HAVING MAXIMUM DIAMETER .021" (.533mm) MEASURED IN GAUGING PLANE .054" + .001" - .000 (1.37 + .025 - .000mm) BELOW THE REFERENCE PLANE OF THE DEVICE SHALL BE WITHIN .007" (.778mm) THEIR TRUE POSITION RELATIVE TO MAXIMUM WIDTH TAB.
3. FROM CENTERLINE TAB.

3

CQX15, CQX17

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +125°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5,6)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,6)
Continuous Forward Current	100 mA
Forward Current (pw, 1 μS ; 200 Hz)	10 A
Reverse Voltage	3 Volts
Power Dissipation ($T_A = 25^\circ\text{C}$)	170 mW ⁽¹⁾
Power Dissipation ($T_C = 25^\circ\text{C}$)	1.3 W ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward Voltage	V_F	—		1.7	V	$I_F = 100 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3 \text{ V}$
Peak Emission Wavelength	λ_P		940		nm	$I_F = 100 \text{ mA}$
Emission Angle at 1/2 Power	θ		± 40		Degrees	
Total Power CQX15	P_O	5.4		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Total Power CQX17	P_O	1.5		—	mW	$I_F = 100 \text{ mA}^{(7)}$
Rise Time 0-90% of output	t_r		1.0		μS	
Fall Time 100-10% of output	t_f		1.0		μS	

NOTES

1. Derate power dissipation linearly 1.70mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropanol alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) minimum from housing.
6. As long as leads are not under any stress or spring tension.
7. Total power output, P_O , is the total power radiated by the device into a solid angle of 2π steradians.

TYPICAL CHARACTERISTICS

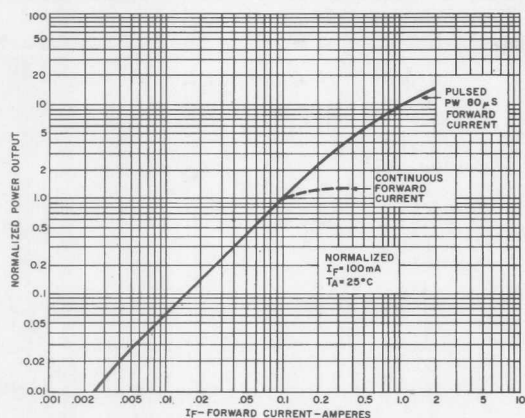


Fig. 1. Power Output vs. Input Current ST1271

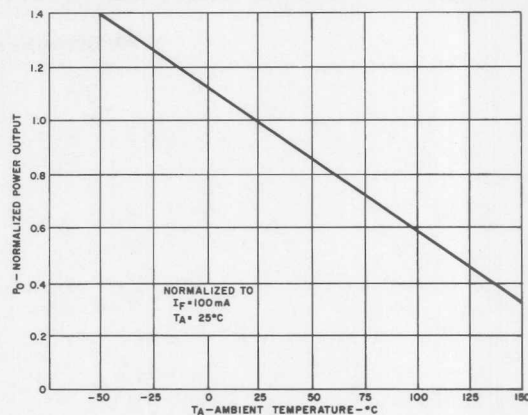


Fig. 2. Power Output vs. Temperature ST1276

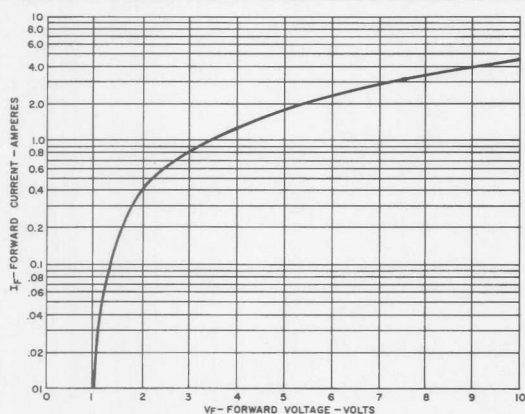


Fig. 3. Forward Voltage vs. Forward Current ST1272

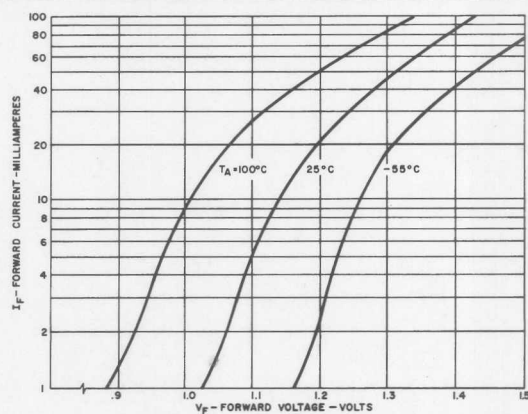


Fig. 4. Forward Voltage vs. Forward Current ST1275

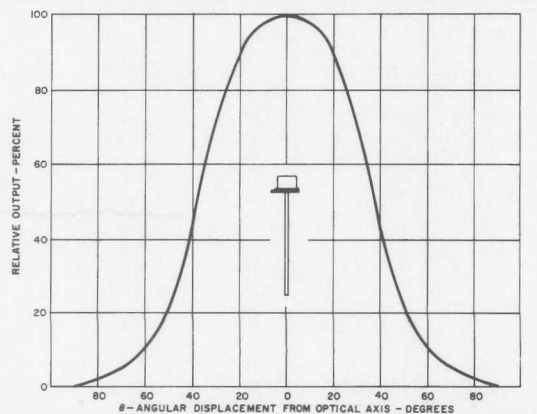


Fig. 5. Typical Radiation Pattern ST1274

TYPICAL CHARACTERISTICS

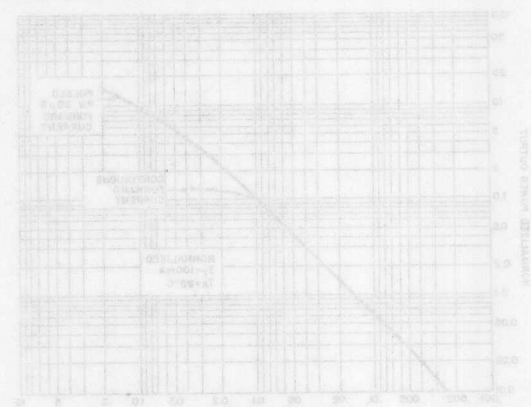


Fig. 1. Power Output vs. Input Current

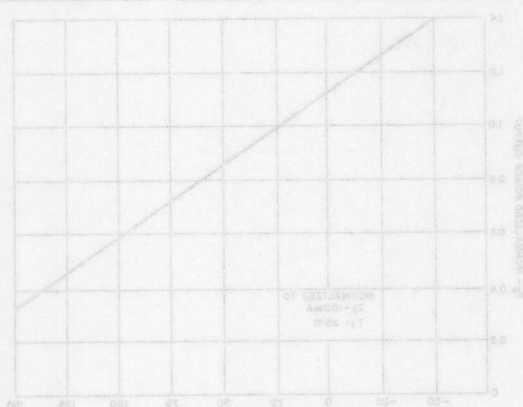


Fig. 2. Power Output vs. Temperature

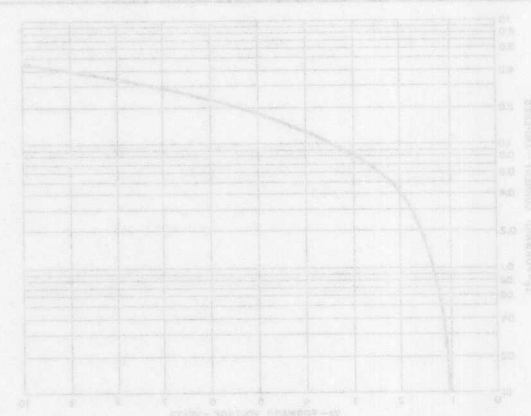


Fig. 3. Forward Voltage vs. Forward Current

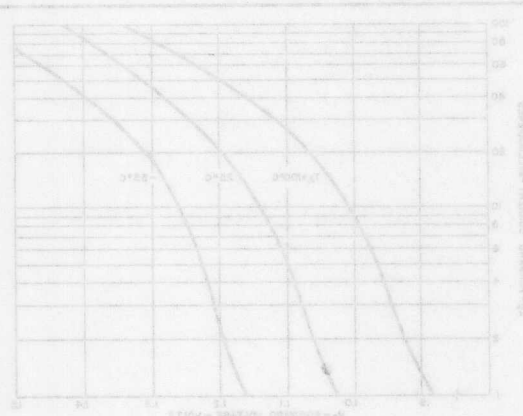


Fig. 4. Forward Voltage vs. Forward Current

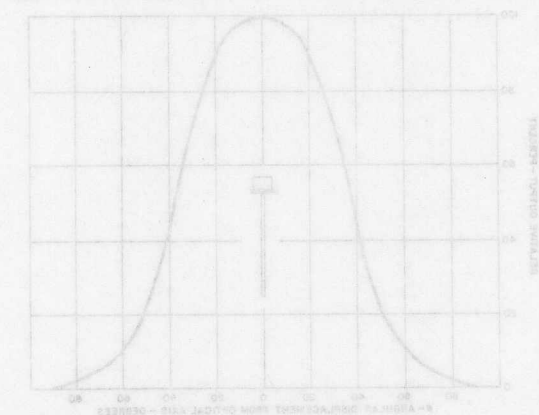
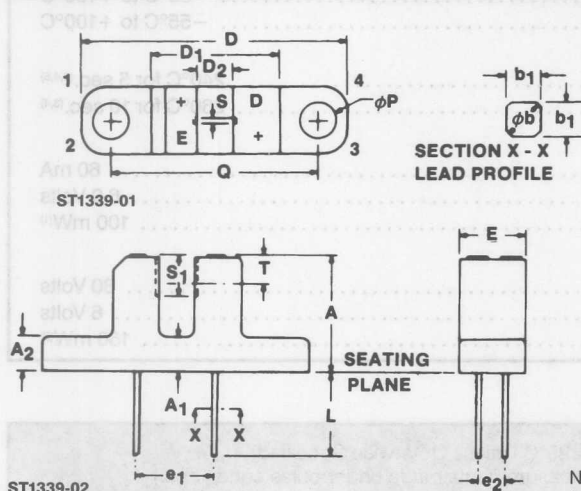


Fig. 5. Typical Radiation Pattern

PACKAGE DIMENSIONS

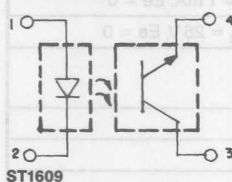


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
A ₂	3.0	3.2	.119	.125	
phi b	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D	24.3	24.7	.957	.972	
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
phi p	3.2	3.4	.126	.133	
Q	18.9	19.2	.745	.755	
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" $\pm 0.75\text{mm}$ ($\pm .030$ INCH).

PACKAGE OUTLINE



DESCRIPTION

The H21A Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon phototransistor in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High $I_{C(ON)}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	6 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)
(All measurements made under pulse conditions.)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	6.0		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 25 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μs	
Turn-Off Time	t_{off}		See page 3.		μs	

NOTES

1. Derate power dissipation linearly 1.33 mW/ $^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly 2.00 mW/ $^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on}, AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H21A1	$I_{C(ON)}$	0.15	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 5\text{V}$
H21A2	$I_{C(ON)}$	0.30	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 5\text{V}$
H21A3	$I_{C(ON)}$	0.60	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 5\text{V}$
H21A1	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 20\text{mA}$, $V_{CE} = 5\text{V}$
H21A2	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 20\text{mA}$, $V_{CE} = 5\text{V}$
H21A3	$I_{C(ON)}$	4.0	—	—	mA	$I_F = 20\text{mA}$, $V_{CE} = 5\text{V}$
H21A1	$I_{C(ON)}$	1.9	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$
H21A2	$I_{C(ON)}$	3.0	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$
H21A3	$I_{C(ON)}$	5.5	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$
SATURATION VOLTAGE						
H21A2	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20\text{mA}$, $I_C = 1.8\text{mA}$
H21A3	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20\text{mA}$, $I_C = 1.8\text{mA}$
H21A1	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 30\text{mA}$, $I_C = 1.8\text{mA}$
Turn-On Time	t_{on}	—	8	—	μS	$V_{CC} = 5\text{V}$, $I_F = 30\text{mA}$, $R_L = 2.5\text{K}\Omega$
Turn-Off Time	t_{off}	—	50	—	μS	$V_{CC} = 5\text{V}$, $I_F = 30\text{mA}$, $R_L = 2.5\text{K}\Omega$

TYPICAL CHARACTERISTICS

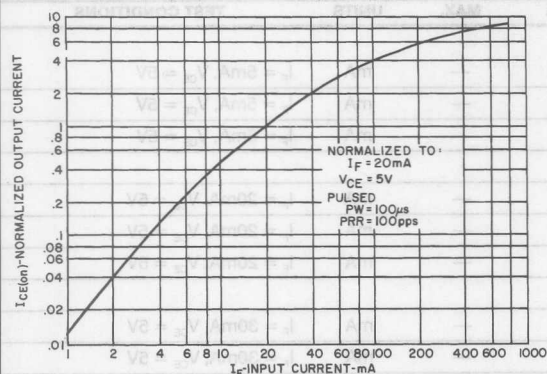


Fig. 1. Output Current vs. Input Current

ST1129-11

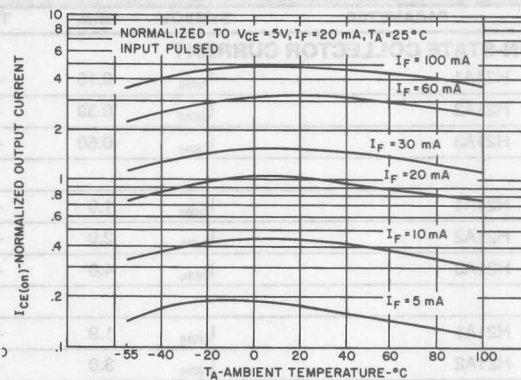


Fig. 2. Output Current vs. Temperature

ST1134-11

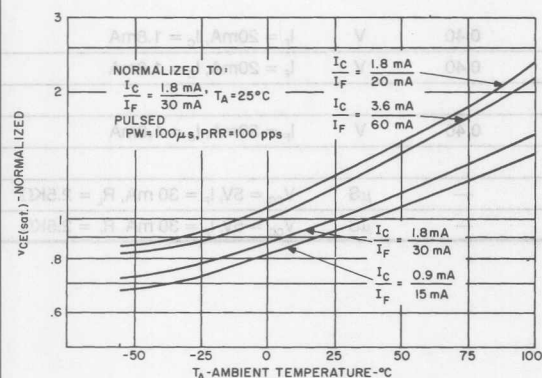


Fig. 3. $V_{CE(sat)}$ vs. Temperature

ST1130-11

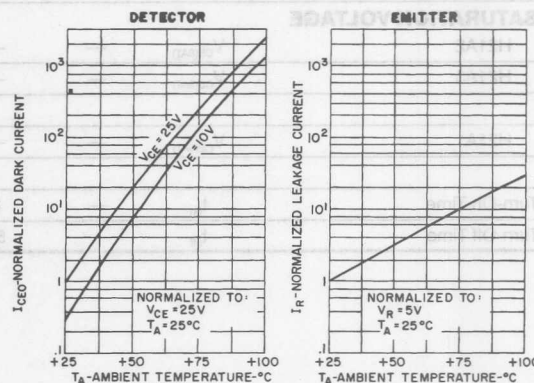


Fig. 4. Leakage Currents vs. Temperature

ST1133-11

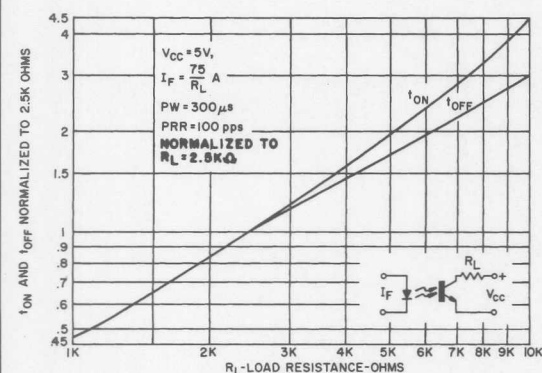


Fig. 5. Switching Speed vs. R_L

ST1131-11

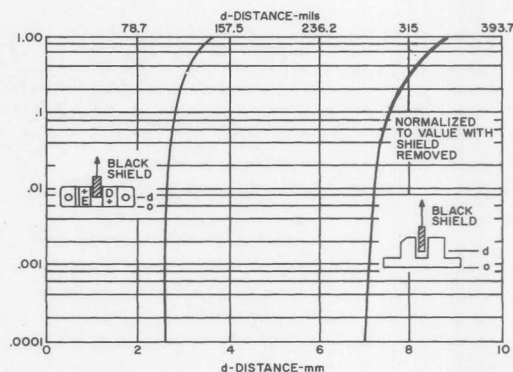
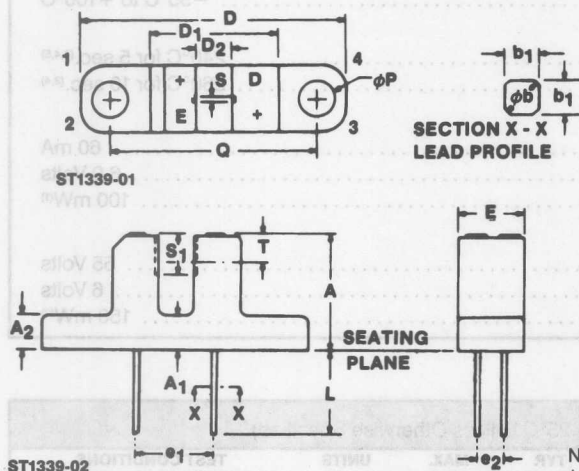


Fig. 6. Output Current vs. Distance

ST1132-11

PACKAGE DIMENSIONS

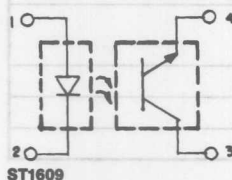


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
A ₂	3.0	3.2	.119	.125	
phi b	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D	24.3	24.7	.957	.972	
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
phi p	3.2	3.4	.126	.133	
Q	18.9	19.2	.745	.755	
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" $\pm 0.75\text{mm}$ (± 0.030 INCH).

PACKAGE OUTLINE



DESCRIPTION

The H21A Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon phototransistor in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High $I_{C(ON)}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	55 Volts
Emitter-Collector Voltage	6 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	6.0		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	55		—	V	$I_C = 1 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 45 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{ON}		See page 3.		μS	
Turn-Off Time	t_{OFF}		See page 3.		μS	

NOTES

1. Derate power dissipation linearly $1.33 \text{ mW}/^\circ\text{C}$ above 25°C ambient.
2. Derate power dissipation linearly $2.00 \text{ mW}/^\circ\text{C}$ above 25°C case.
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on}, AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H21A4	$I_{C(ON)}$	0.15	—	—	mA	$I_F = 5mA$, $V_{CE} = 5V$
H21A5	$I_{C(ON)}$	0.30	—	—	mA	$I_F = 5mA$, $V_{CE} = 5V$
H21A6	$I_{C(ON)}$	0.60	—	—	mA	$I_F = 5mA$, $V_{CE} = 5V$
H21A4	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 20mA$, $V_{CE} = 5V$
H21A5	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 20mA$, $V_{CE} = 5V$
H21A6	$I_{C(ON)}$	4.0	—	—	mA	$I_F = 20mA$, $V_{CE} = 5V$
H21A4	$I_{C(ON)}$	1.9	—	—	mA	$I_F = 30mA$, $V_{CE} = 5V$
H21A5	$I_{C(ON)}$	3.0	—	—	mA	$I_F = 30mA$, $V_{CE} = 5V$
H21A6	$I_{C(ON)}$	5.5	—	—	mA	$I_F = 30mA$, $V_{CE} = 5V$
SATURATION VOLTAGE						
H21A5	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20mA$, $I_C = 1.8mA$
H21A6	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20mA$, $I_C = 1.8mA$
H21A4	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 30mA$, $I_C = 1.8mA$
Turn-On Time	t_{on}	—	8	—	μS	$V_{CC} = 5V$, $I_F = 30mA$, $R_L = 2.5K\Omega$
Turn-Off Time	t_{off}	—	50	—	μS	$V_{CC} = 5V$, $I_F = 30mA$, $R_L = 2.5K\Omega$

TYPICAL CHARACTERISTICS

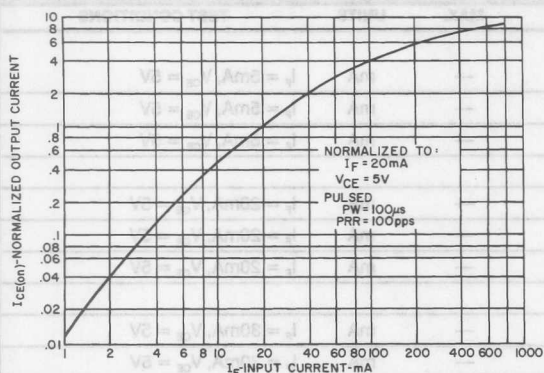


Fig. 1. Output Current vs. Input Current

ST1140-11

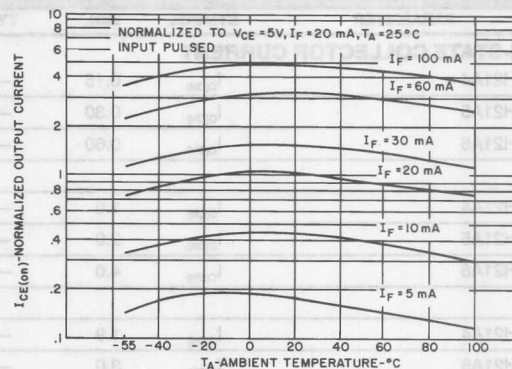


Fig. 2. Output Current vs. Temperature

ST1144-11

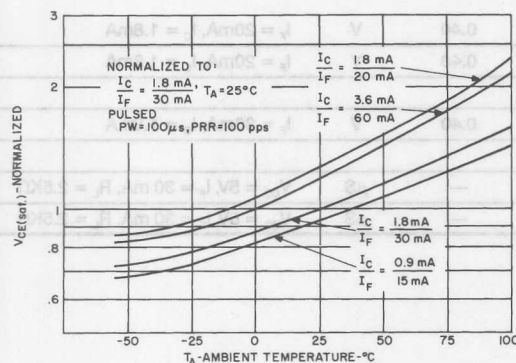


Fig. 3. $V_{CE(SAT)}$ vs. Temperature

ST1141-11

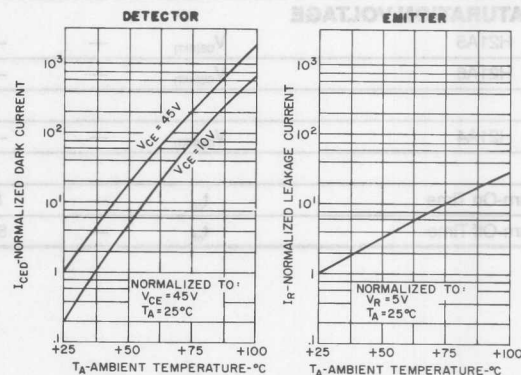


Fig. 4. Leakage Current vs. Temperature

ST1145-11

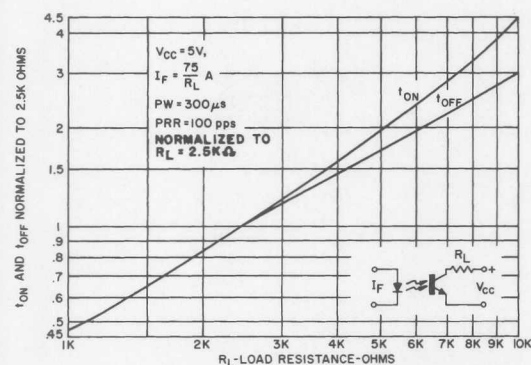


Fig. 5. Switching Speed vs. R_L

ST1142-11

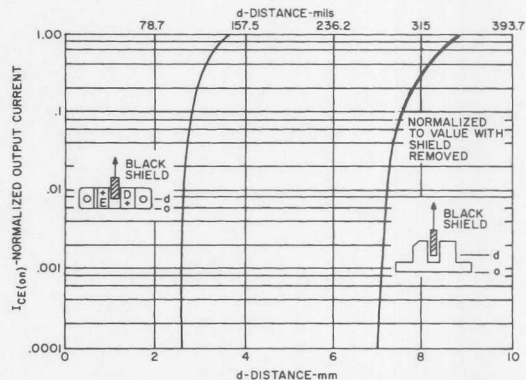
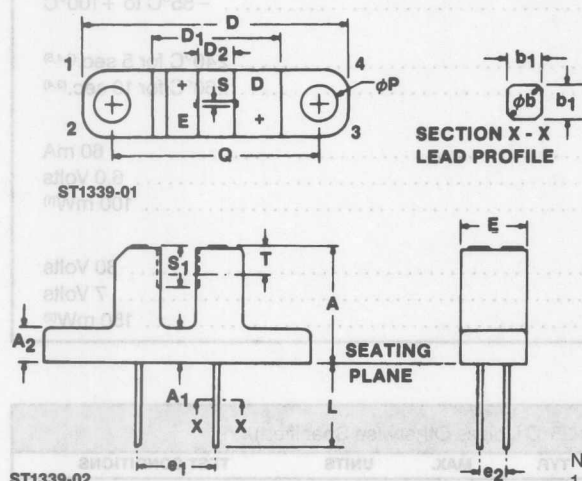


Fig. 6. Output Current vs. Shield Distance

ST1143-11

PACKAGE DIMENSIONS

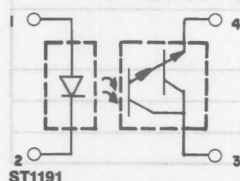


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
A ₂	3.0	3.2	.119	.125	
φb	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D	24.3	24.7	.957	.972	
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
φp	3.2	3.4	.126	.133	
Q	18.9	19.2	.745	.755	
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ±0.75mm (±.030 INCH).

PACKAGE OUTLINE



DESCRIPTION

The H21B Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon photodarlington in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High I_{C(ON)}

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	7 Volts
Power Dissipation	150 mW ⁽²⁾

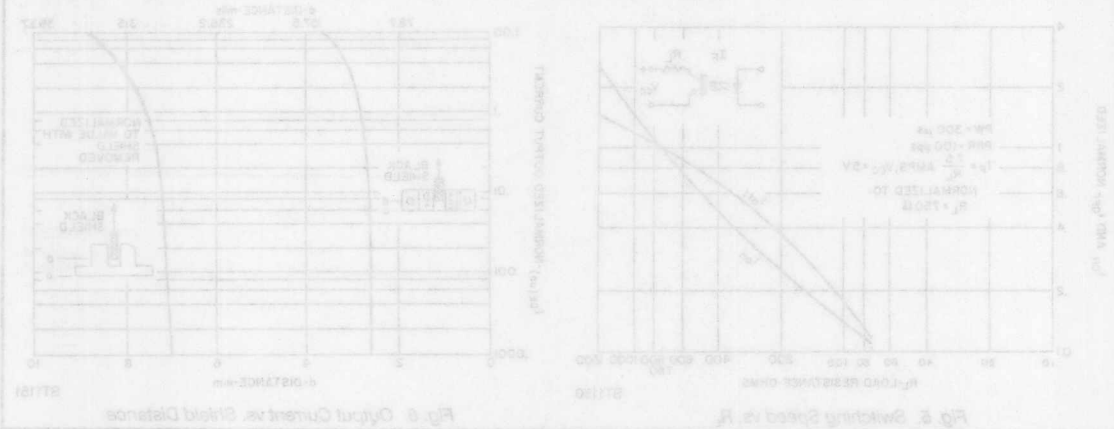
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3 \text{ V}$
OUTPUT DARLINGTON						
Emitter-Collector Breakdown	BV_{ECO}	7.0		—	V	$I_E = 100 \mu\text{A}, E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1 \text{ mA}, E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 25 \text{ V}, E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μs	
Turn-Off Time	t_{off}		See page 3.		μs	

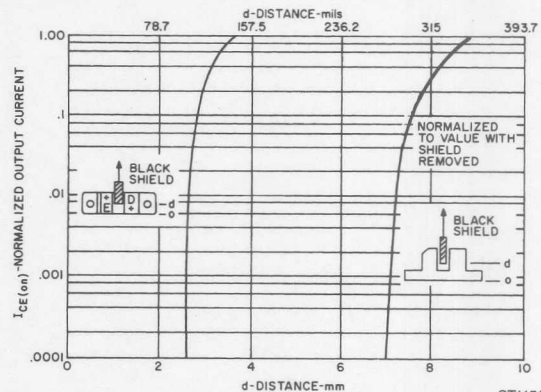
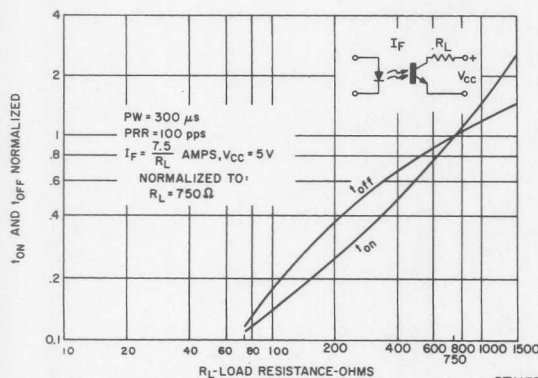
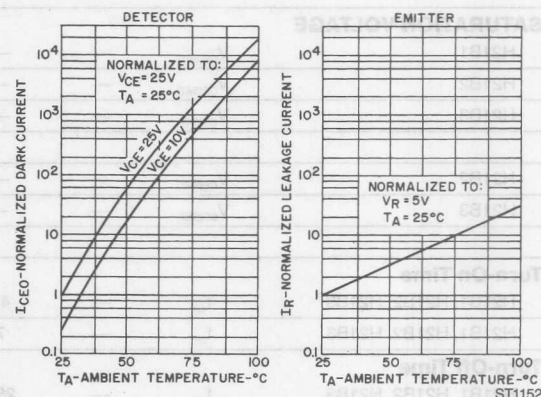
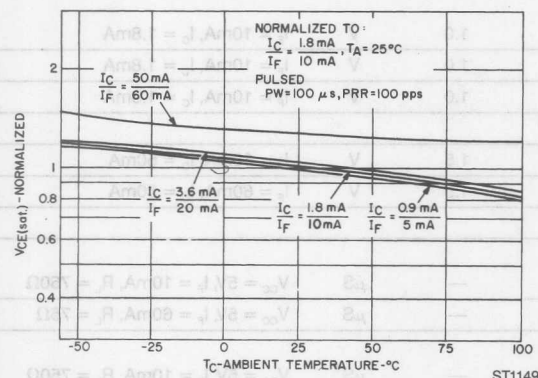
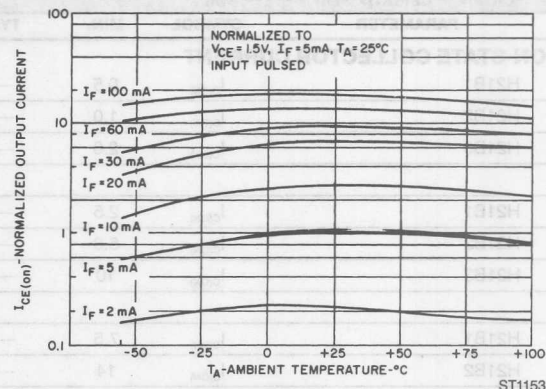
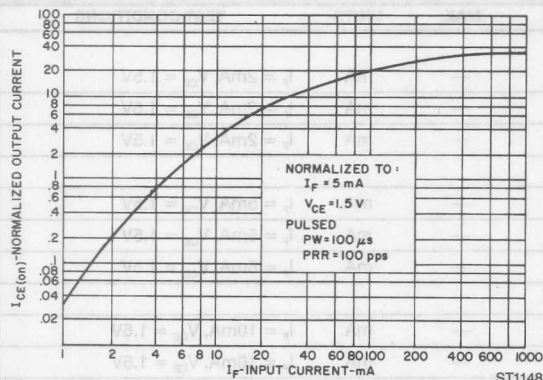
NOTES

1. Derate power dissipation linearly $1.33 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16"$ (1.6 mm) from housing.

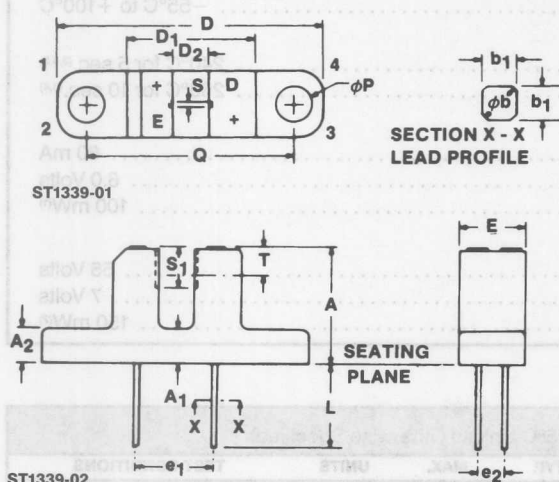
$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on} AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H21B1	$I_{C(ON)}$	0.5	—	—	mA	$I_F = 2mA, V_{CE} = 1.5V$
H21B2	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 2mA, V_{CE} = 1.5V$
H21B3	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 2mA, V_{CE} = 1.5V$
H21B1	$I_{C(ON)}$	2.5	—	—	mA	$I_F = 5mA, V_{CE} = 1.5V$
H21B2	$I_{C(ON)}$	5.0	—	—	mA	$I_F = 5mA, V_{CE} = 1.5V$
H21B3	$I_{C(ON)}$	10	—	—	mA	$I_F = 5mA, V_{CE} = 1.5V$
H21B1	$I_{C(ON)}$	7.5	—	—	mA	$I_F = 10mA, V_{CE} = 1.5V$
H21B2	$I_{C(ON)}$	14	—	—	mA	$I_F = 10mA, V_{CE} = 1.5V$
H21B3	$I_{C(ON)}$	25	—	—	mA	$I_F = 10mA, V_{CE} = 1.5V$
SATURATION VOLTAGE						
H21B1	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10mA, I_C = 1.8mA$
H21B2	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10mA, I_C = 1.8mA$
H21B3	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10mA, I_C = 1.8mA$
H21B2	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60mA, I_C = 50mA$
H21B3	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60mA, I_C = 50mA$
Turn-On Time						
H21B1, H21B2, H21B3	t_{on}	—	45	—	μS	$V_{CC} = 5V, I_F = 10mA, R_L = 750\Omega$
H21B1, H21B2, H21B3	t_{on}	—	7	—	μS	$V_{CC} = 5V, I_F = 60mA, R_L = 75\Omega$
Turn-Off Time						
H21B1, H21B2, H21B3	t_{off}	—	250	—	μS	$V_{CC} = 5V, I_F = 10mA, R_L = 750\Omega$
H21B1, H21B2, H21B3	t_{off}	—	45	—	μS	$V_{CC} = 5V, I_F = 60mA, R_L = 75\Omega$



TYPICAL CHARACTERISTICS



PACKAGE DIMENSIONS

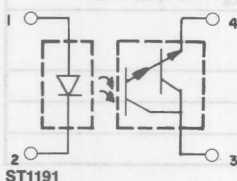


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
A ₂	3.0	3.2	.119	.125	
φb	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D	24.3	24.7	.957	.972	
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
φp	3.2	3.4	.126	.133	
Q	18.9	19.2	.745	.755	
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T": $\pm 0.75\text{mm}$ ($\pm .030$ INCH).

PACKAGE OUTLINE



DESCRIPTION

The H21B Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon photodarlington in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High $I_{C(ON)}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	55 Volts
Emitter-Collector Voltage	7 Volts
Power Dissipation	150 mW ⁽²⁾

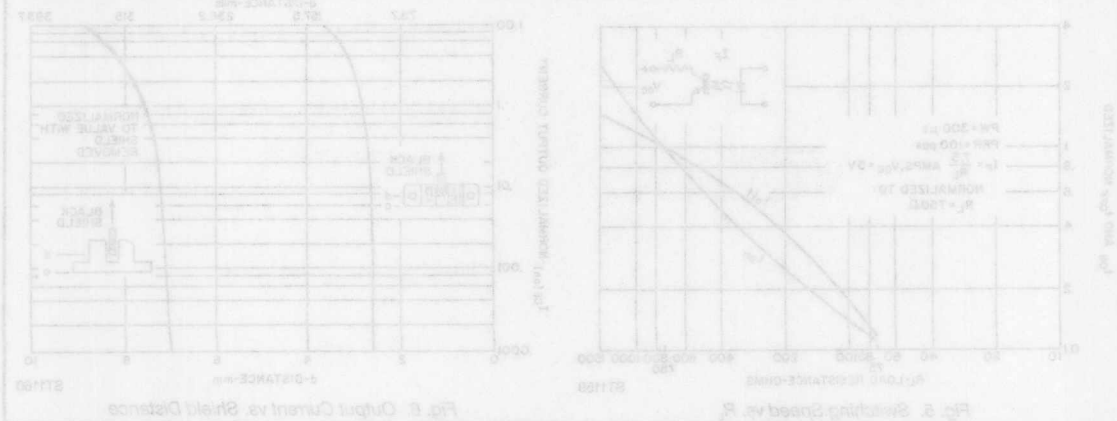
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3 \text{ V}$
OUTPUT DARLINGTON						
Emitter-Collector Breakdown	BV_{ECO}	7.0		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	55		—	V	$I_C = 1 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 45 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μs	
Turn-Off Time	t_{off}		See page 3.		μs	

NOTES

1. Derate power dissipation linearly 1.33 mW/ $^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly 2.00 mW/ $^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on}, AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H21B4	$I_{C(ON)}$	0.5	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B5	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B6	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B4	$I_{C(ON)}$	2.5	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B5	$I_{C(ON)}$	5.0	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B6	$I_{C(ON)}$	10	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B4	$I_{C(ON)}$	7.5	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B5	$I_{C(ON)}$	14	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
H21B6	$I_{C(ON)}$	25	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
SATURATION VOLTAGE						
H21B4	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H21B5	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H21B6	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H21B5	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60\text{mA}$, $I_C = 50\text{mA}$
H21B6	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60\text{mA}$, $I_C = 50\text{mA}$
Turn-On Time						
H21B4, H21B5, H21B6	t_{on}	—	45	—	μS	$V_{CC} = 5\text{V}$, $I_F = 10\text{mA}$, $R_L = 750\Omega$
H21B4, H21B5, H21B6	t_{on}	—	7	—	μS	$V_{CC} = 5\text{V}$, $I_F = 60\text{mA}$, $R_L = 75\Omega$
Turn-Off Time						
H21B4, H21B5, H21B6	t_{off}	—	250	—	μS	$V_{CC} = 5\text{V}$, $I_F = 10\text{mA}$, $R_L = 750\Omega$
H21B4, H21B5, H21B6	t_{off}	—	45	—	μS	$V_{CC} = 5\text{V}$, $I_F = 60\text{mA}$, $R_L = 75\Omega$



TYPICAL CHARACTERISTICS

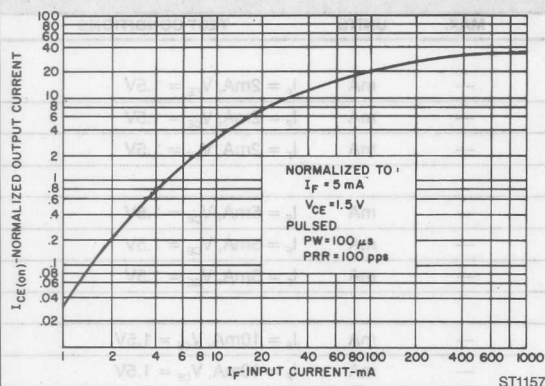


Fig. 1. Output Current vs. Input Current

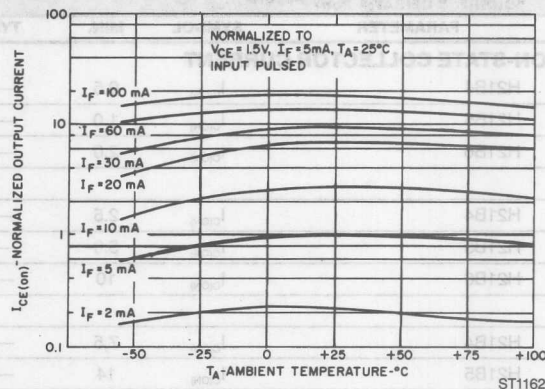


Fig. 2. Output Current vs. Temperature

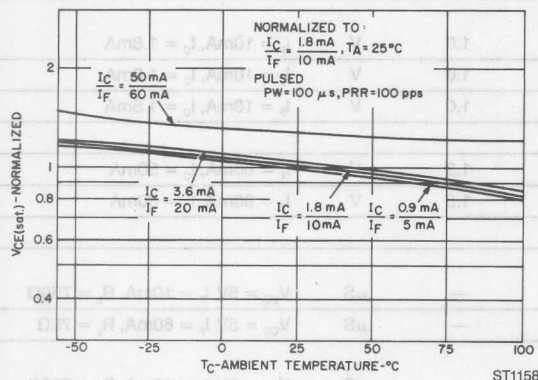


Fig. 3. $V_{CE(sat)}$ vs. Temperature

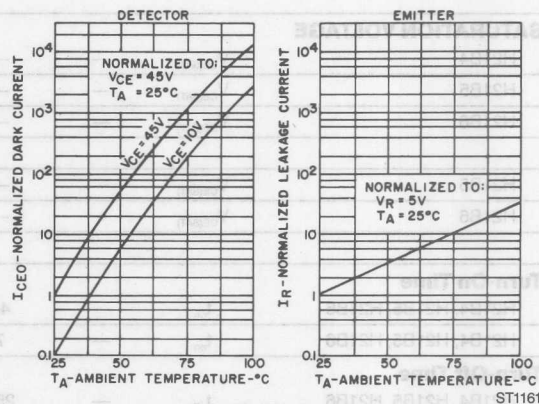


Fig. 4. Leakage Currents vs. Temperature

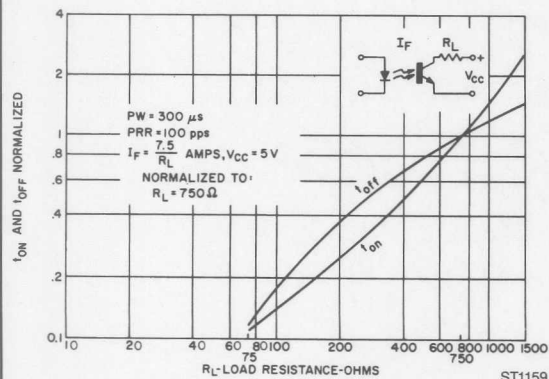


Fig. 5. Switching Speed vs. R_L

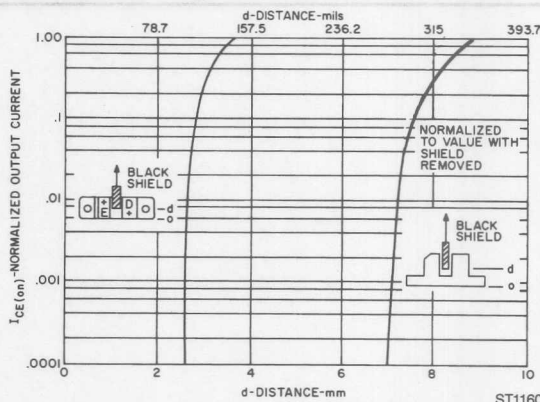
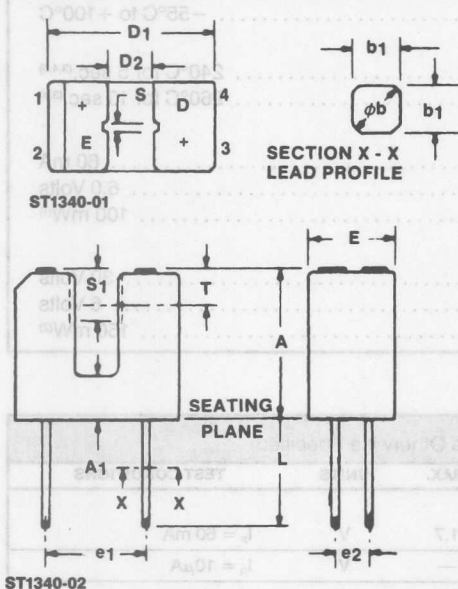


Fig. 6. Output Current vs. Shield Distance

PACKAGE DIMENSIONS

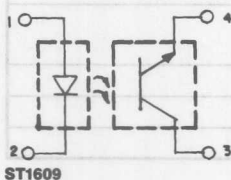


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
φb	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ±0.75mm (±.030 INCH).

PACKAGE OUTLINE



DESCRIPTION

The H22A Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon photodarlington in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High I_{C(ON)}

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	6 Volts
Power Dissipation	150 mW ⁽²⁾

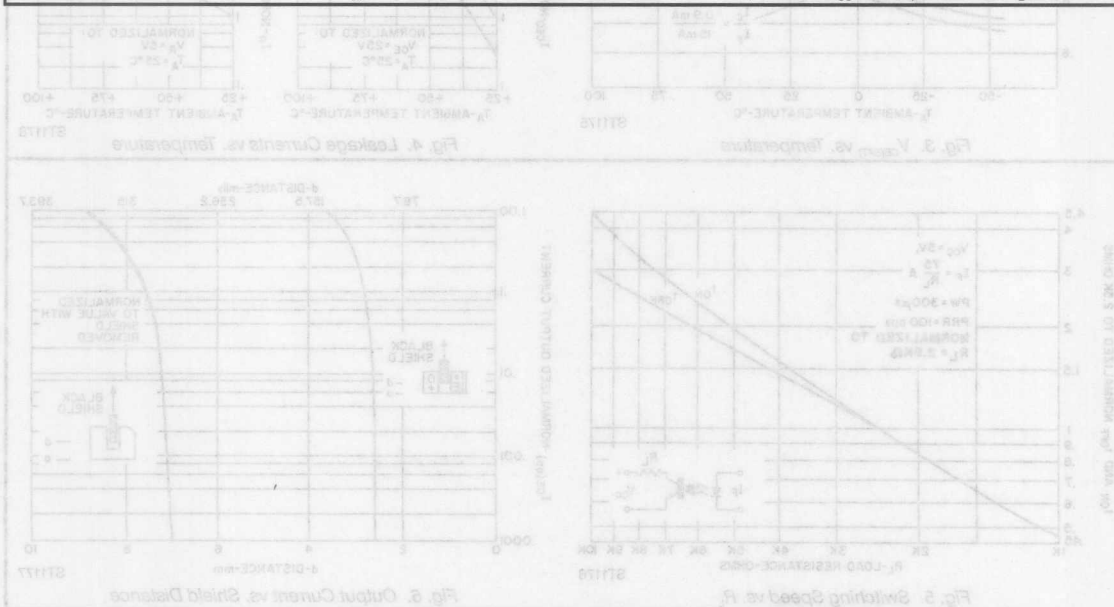
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60\text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10\mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3\text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	6.0		—	V	$I_E = 100\mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1\text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 25\text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μS	
Turn-Off Time	t_{off}		See page 3.		μS	

NOTES

1. Derate power dissipation linearly $1.33\text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00\text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on}, AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H22A1	$I_{C(ON)}$	0.15	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 5\text{V}$
H22A2	$I_{C(ON)}$	0.30	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 5\text{V}$
H22A3	$I_{C(ON)}$	0.60	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 5\text{V}$
H22A1	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 20\text{mA}$, $V_{CE} = 5\text{V}$
H22A2	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 20\text{mA}$, $V_{CE} = 5\text{V}$
H22A3	$I_{C(ON)}$	4.0	—	—	mA	$I_F = 20\text{mA}$, $V_{CE} = 5\text{V}$
H22A1	$I_{C(ON)}$	1.9	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$
H22A2	$I_{C(ON)}$	3.0	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$
H22A3	$I_{C(ON)}$	5.5	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$
SATURATION VOLTAGE						
H22A2	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20\text{mA}$, $I_C = 1.8\text{mA}$
H22A3	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20\text{mA}$, $I_C = 1.8\text{mA}$
H22A1	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 30\text{mA}$, $I_C = 1.8\text{mA}$
Turn-On Time	t_{on}	—	8	—	μS	$V_{CC} = 5\text{V}$, $I_F = 30\text{mA}$, $R_L = 2.5\text{K}\Omega$
Turn-Off Time	t_{off}	—	50	—	μS	$V_{CC} = 5\text{V}$, $I_F = 30\text{mA}$, $R_L = 2.5\text{K}\Omega$



TYPICAL CHARACTERISTICS

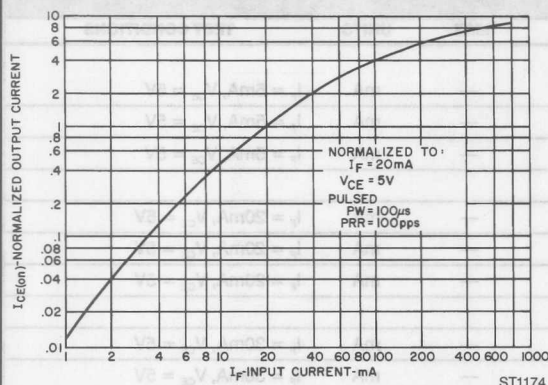


Fig. 1. Output Current vs. Input Current

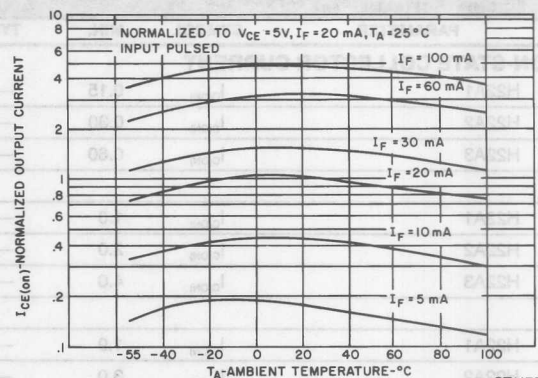


Fig. 2. Output Current vs. Temperature

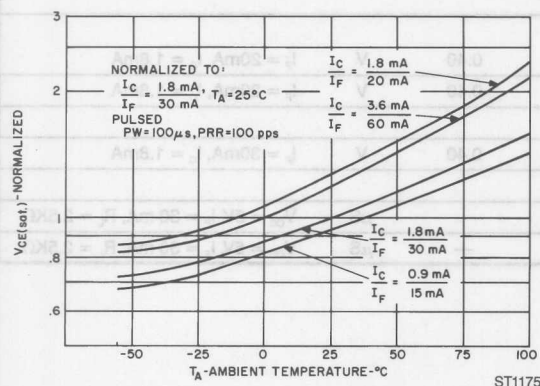


Fig. 3. $V_{CE(SAT)}$ vs. Temperature

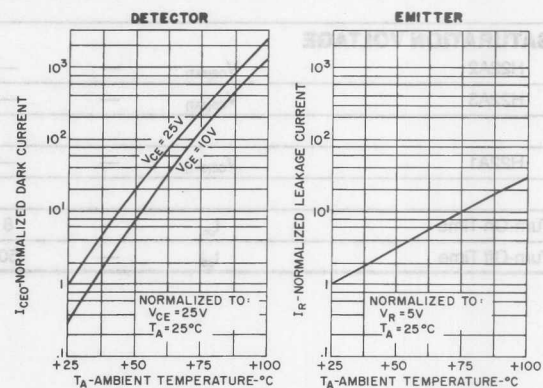


Fig. 4. Leakage Currents vs. Temperature

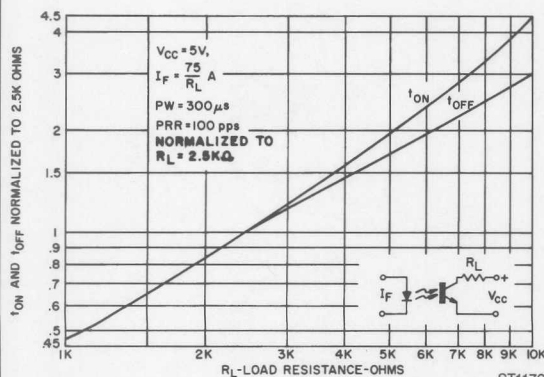


Fig. 5. Switching Speed vs. R_L

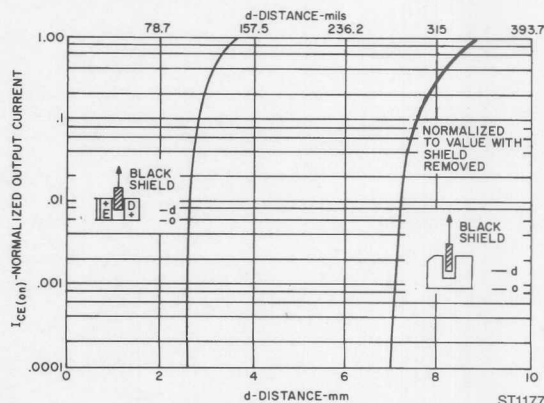
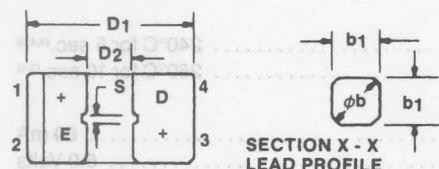
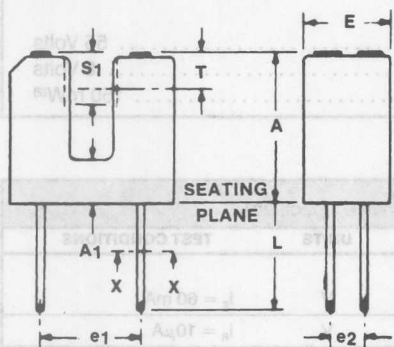


Fig. 6. Output Current vs. Shield Distance

PACKAGE DIMENSIONS

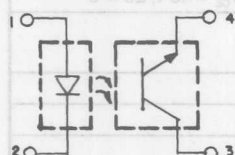


ST1340-01



ST1340-02

PACKAGE OUTLINE



ST1609

DESCRIPTION

The H22A Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon photodarlington in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
φb	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ±0.75mm (±.030 INCH).

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High I_{C(ON)}

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	55 Volts
Emitter-Collector Voltage	6 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	6		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	55		—	V	$I_C = 1 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 45 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μS	
Turn-Off Time	t_{off}		See page 3.		μS	

NOTES

1. Derate power dissipation linearly $1.33 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16"$ (1.6 mm) from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on} AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H22A4	$I_{C(ON)}$	0.15	—	—	mA	$I_F = 5mA, V_{CE} = 5V$
H22A5	$I_{C(ON)}$	0.30	—	—	mA	$I_F = 5mA, V_{CE} = 5V$
H22A6	$I_{C(ON)}$	0.60	—	—	mA	$I_F = 5mA, V_{CE} = 5V$
H22A4	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 20mA, V_{CE} = 5V$
H22A5	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 20mA, V_{CE} = 5V$
H22A6	$I_{C(ON)}$	4.0	—	—	mA	$I_F = 20mA, V_{CE} = 5V$
H22A4	$I_{C(ON)}$	1.9	—	—	mA	$I_F = 30mA, V_{CE} = 5V$
H22A5	$I_{C(ON)}$	3.0	—	—	mA	$I_F = 30mA, V_{CE} = 5V$
H22A6	$I_{C(ON)}$	5.5	—	—	mA	$I_F = 30mA, V_{CE} = 5V$
SATURATION VOLTAGE						
H22A5	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20mA, I_C = 1.8mA$
H22A6	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 20mA, I_C = 1.8mA$
H22A4	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 30mA, I_C = 1.8mA$
Turn-On Time	t_{on}	—	8	—	μS	$V_{CC} = 5V, I_F = 30mA, R_L = 2.5K\Omega$
Turn-Off Time	t_{off}	—	50	—	μS	$V_{CC} = 5V, I_F = 30mA, R_L = 2.5K\Omega$

TYPICAL CHARACTERISTICS

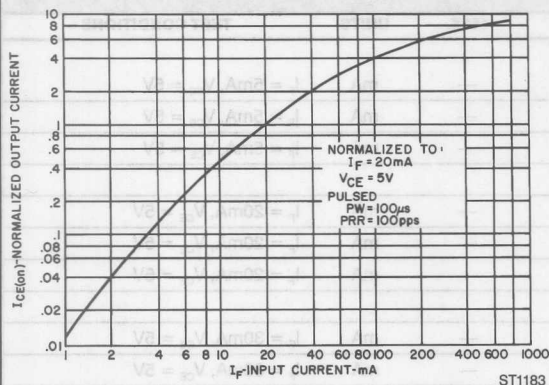


Fig. 1. Output Current vs. Input Current

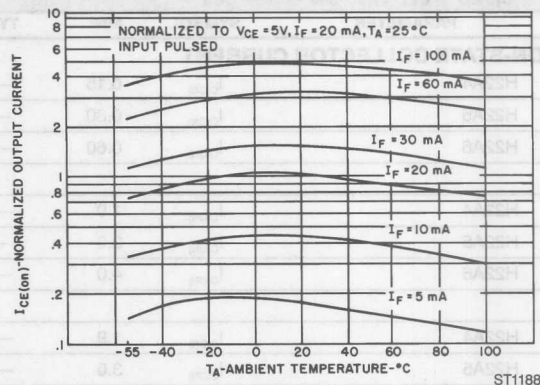


Fig. 2. Output Current vs. Temperature

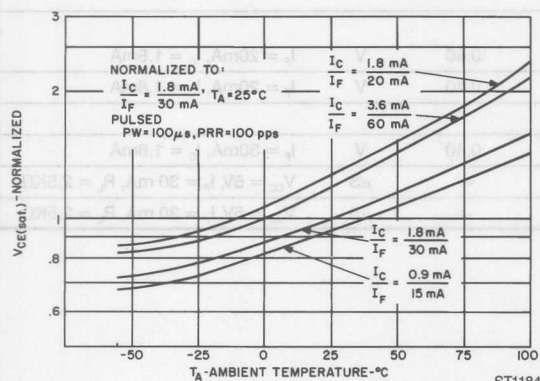


Fig. 3. $V_{CE(SAT)}$ vs. Temperature

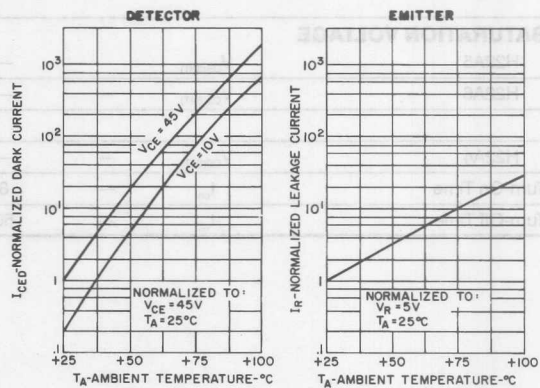


Fig. 4. Leakage Currents vs. Temperature

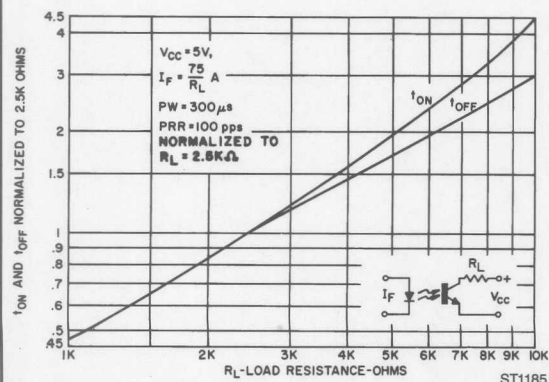


Fig. 5. Switching Speed vs. R_L

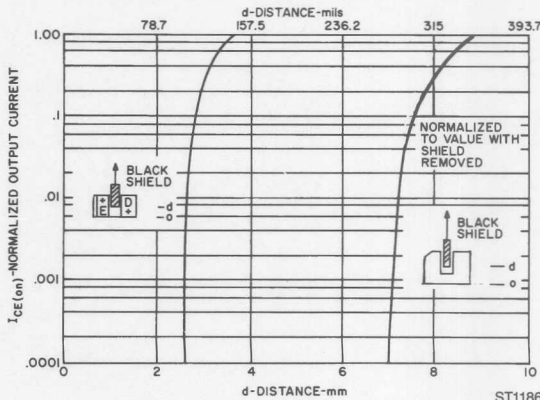
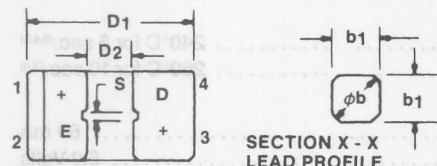
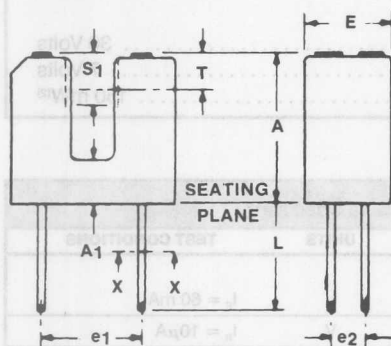


Fig. 6. Output Current vs. Shield Distance

PACKAGE DIMENSIONS

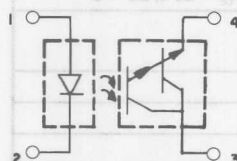


ST1340-01



ST1340-02

PACKAGE OUTLINE



ST1191

DESCRIPTION

The H22B Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon photodarlington in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
phi b	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" $\pm 0.75\text{mm}$ ($\pm .030$ INCH).

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High $I_{C(ON)}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	7 Volts
Power Dissipation	150 mW ⁽²⁾

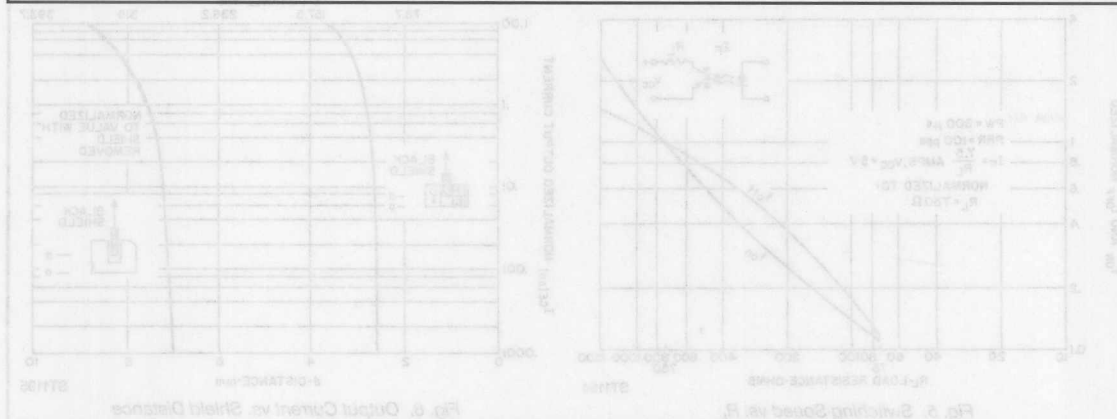
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3 \text{ V}$
OUTPUT DARLINGTON						
Emitter-Collector Breakdown	BV_{ECO}	7.0		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 1 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 25 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μs	
Turn-Off Time	t_{off}		See page 3.		μs	

NOTES

1. Derate power dissipation linearly $1.33 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on}, AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H22B1	$I_{C(ON)}$	0.5	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B2	$I_{C(ON)}$	1.0	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B3	$I_{C(ON)}$	2.0	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B1	$I_{C(ON)}$	2.5	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B2	$I_{C(ON)}$	5.0	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B3	$I_{C(ON)}$	10	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B1	$I_{C(ON)}$	7.5	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B2	$I_{C(ON)}$	14	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B3	$I_{C(ON)}$	25	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
SATURATION VOLTAGE						
H22B1	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H22B2	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H22B3	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H22B2	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60\text{mA}$, $I_C = 50\text{mA}$
H22B3	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60\text{mA}$, $I_C = 50\text{mA}$
Turn-On Time						
H22B1, H22B2, H22B3	t_{on}	—	45	—	μS	$V_{CC} = 5\text{V}$, $I_F = 10\text{mA}$, $R_L = 750\Omega$
H22B1, H22B2, H22B3	t_{on}	—	7	—	μS	$V_{CC} = 5\text{V}$, $I_F = 60\text{mA}$, $R_L = 75\Omega$
Turn-Off Time						
H22B1, H22B2, H22B3	t_{off}	—	250	—	μS	$V_{CC} = 5\text{V}$, $I_F = 10\text{mA}$, $R_L = 750\Omega$
H22B1, H22B2, H22B3	t_{off}	—	45	—	μS	$V_{CC} = 5\text{V}$, $I_F = 60\text{mA}$, $R_L = 75\Omega$



TYPICAL CHARACTERISTICS

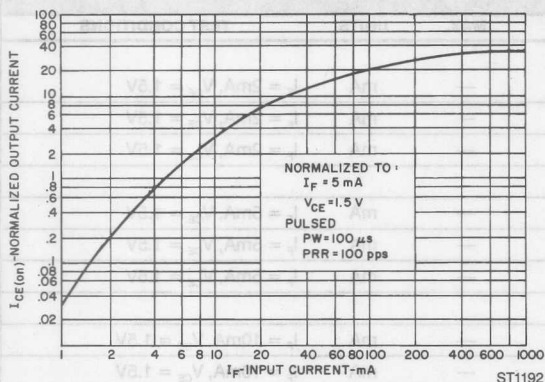


Fig. 1. Output Current vs. Input Current

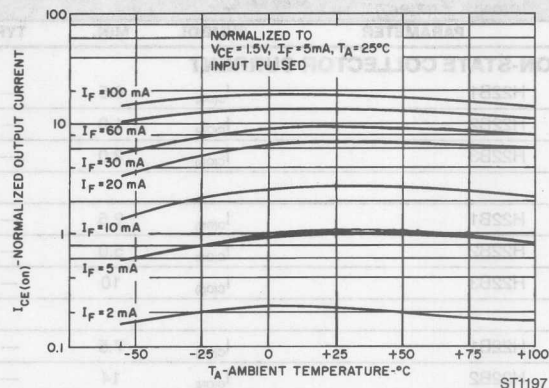


Fig. 2. Output Current vs. Temperature

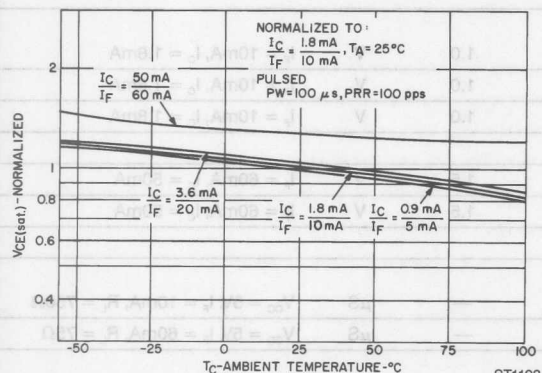


Fig. 3. $V_{CE(SAT)}$ vs. Temperature

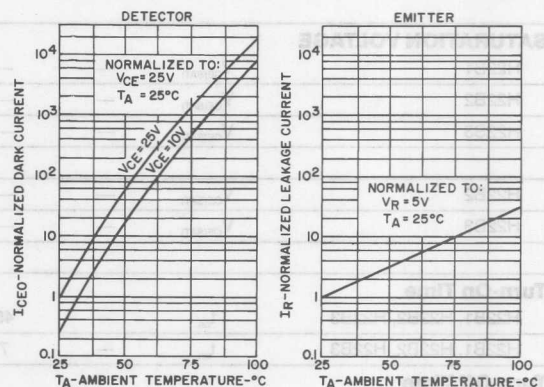


Fig. 4. Leakage Currents vs. Temperature

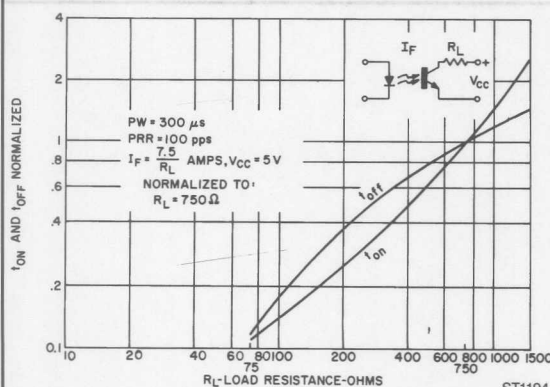


Fig. 5. Switching Speed vs. R_L

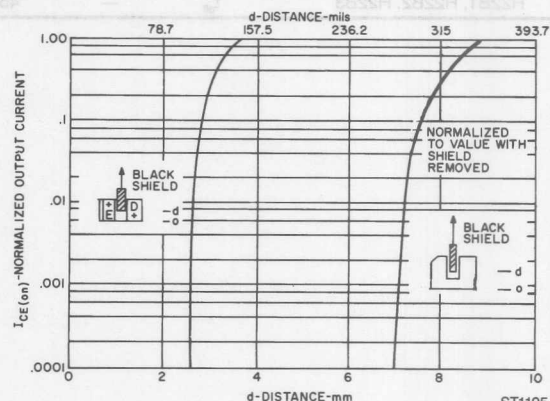
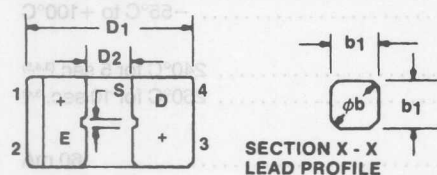
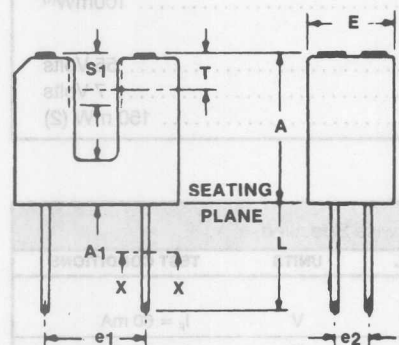


Fig. 6. Output Current vs. Shield Distance

PACKAGE DIMENSIONS



ST1340-01



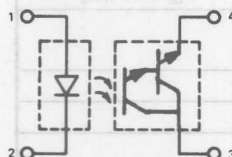
ST1340-02

SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
φb	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS, LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27 MM (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ± 0.75 MM (± .030 INCH).

PACKAGE OUTLINE



ST1199

DESCRIPTION

The H22B Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a silicon photodarlington in a plastic housing. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- High I_{C(ON)}

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	55 Volts
Emitter-Collector Voltage	7 Volts
Power Dissipation	150 mW ⁽²⁾

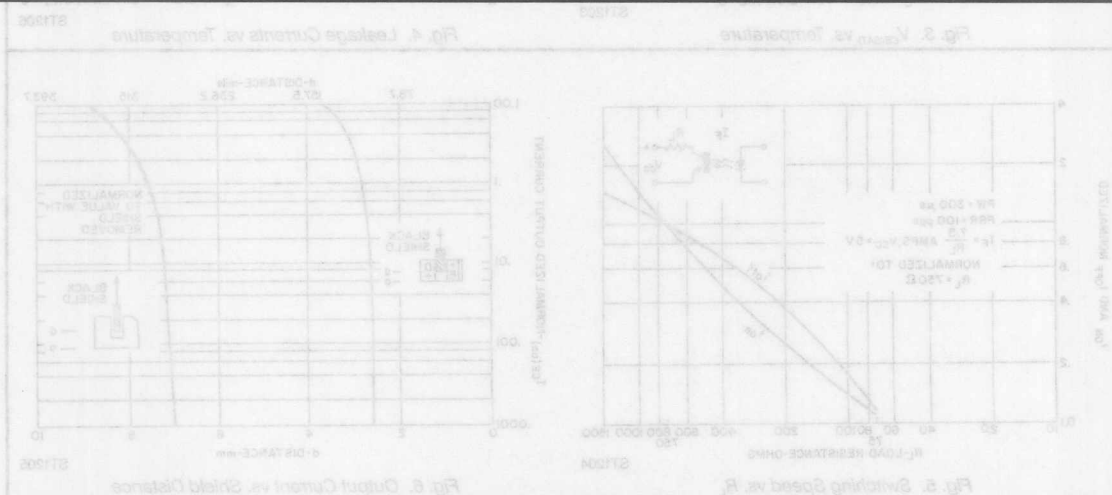
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60 \text{ mA}$
Reverse Breakdown Voltage	V_R	6.0		—	V	$I_R = 10 \mu\text{A}$
Reverse Leakage Current	I_R	—		1.0	μA	$V_R = 3\text{V}$
OUTPUT DARLINGTON						
Emitter-Collector Breakdown	BV_{ECO}	7.0		—	V	$I_E = 100 \mu\text{A}$, $E_o = 0$
Collector-Emitter Breakdown	BV_{CEO}	55		—	V	$I_C = 1 \text{ mA}$, $E_o = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 45 \text{ V}$, $E_o = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.		mA	
Saturation Voltage	$V_{CE(SAT)}$		See page 3.		V	
Turn-On Time	t_{on}		See page 3.		μs	
Turn-Off Time	t_{off}		See page 3.		μs	

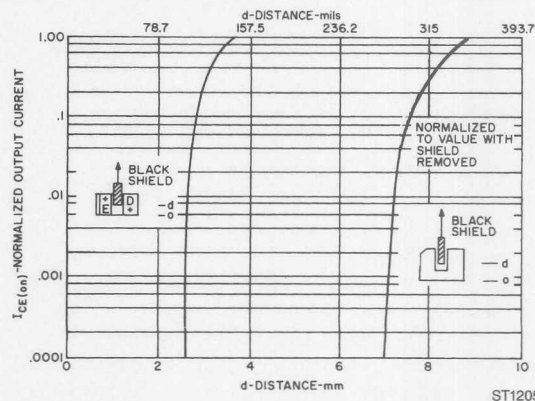
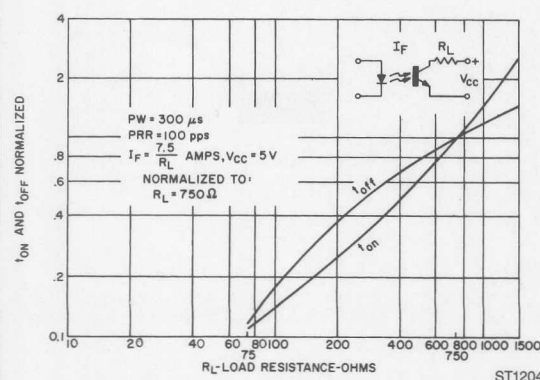
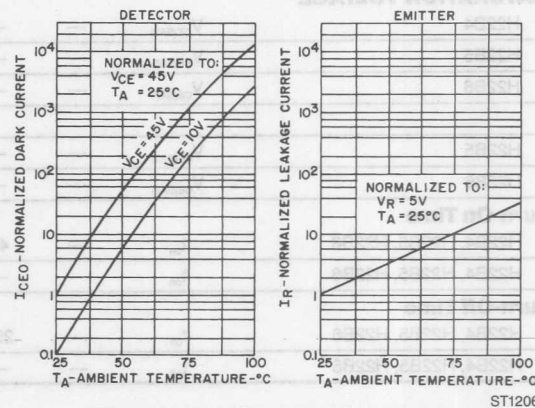
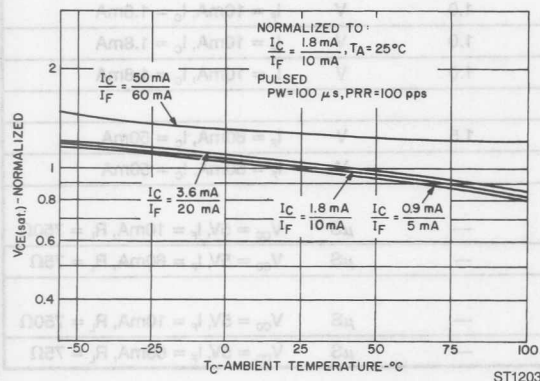
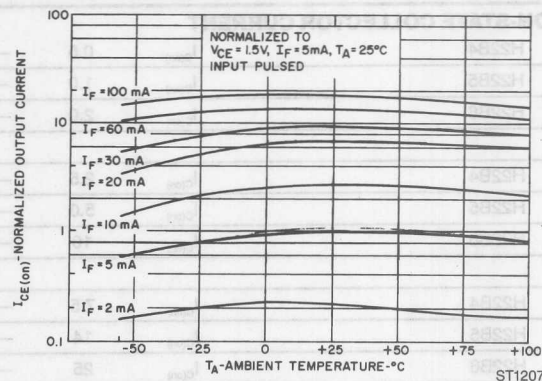
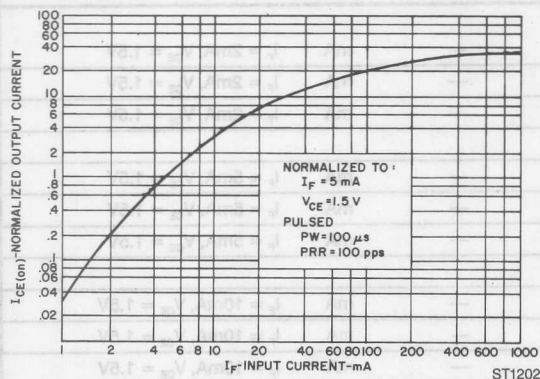
NOTES

1. Derate power dissipation linearly $1.33\text{mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00\text{mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.

$I_{C(ON)}$, $V_{CE(SAT)}$, t_{on}, AND t_{off}						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H22B4	$I_{C(on)}$	0.5	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B5	$I_{C(on)}$	1.0	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B6	$I_{C(on)}$	2.0	—	—	mA	$I_F = 2\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B4	$I_{C(on)}$	2.5	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B5	$I_{C(on)}$	5.0	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B6	$I_{C(on)}$	10	—	—	mA	$I_F = 5\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B4	$I_{C(on)}$	7.5	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B5	$I_{C(on)}$	14	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
H22B6	$I_{C(on)}$	25	—	—	mA	$I_F = 10\text{mA}$, $V_{CE} = 1.5\text{V}$
SATURATION VOLTAGE						
H22B4	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H22B5	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H22B6	$V_{CE(SAT)}$	—	—	1.0	V	$I_F = 10\text{mA}$, $I_C = 1.8\text{mA}$
H22B5	$V_{CE(SAT)}$	—	—	1.5	V	$I_F = 60\text{mA}$, $I_C = 50\text{mA}$
H22B6	$V_{CE(SAT)}$	—	—	—	V	$I_F = 60\text{mA}$, $I_C = 50\text{mA}$
Turn-On Time						
H22B4, H22B5, H22B6	t_{on}	—	45	—	μS	$V_{CC} = 5\text{V}$, $I_F = 10\text{mA}$, $R_L = 750\Omega$
H22B4, H22B5, H22B6	t_{on}	—	—	—	μS	$V_{CC} = 5\text{V}$, $I_F = 60\text{mA}$, $R_L = 75\Omega$
Turn-Off Time						
H22B4, H22B5, H22B6	t_{off}	—	250	—	μS	$V_{CC} = 5\text{V}$, $I_F = 10\text{mA}$, $R_L = 750\Omega$
H22B4, H22B5, H22B6	t_{off}	—	—	—	μS	$V_{CC} = 5\text{V}$, $I_F = 60\text{mA}$, $R_L = 75\Omega$



TYPICAL CHARACTERISTICS



ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+85^\circ\text{C}$
Operating Temperature	-55°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100mW ⁽¹⁾

OUTPUT OPTOLOGIC™

Output Current I_A	50 mA
Allowed Range V_{35}	4 to 16 Volts
Allowed Range V_{45}	2.4 to 16 Volts
Power Dissipation	150 mW (2)

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

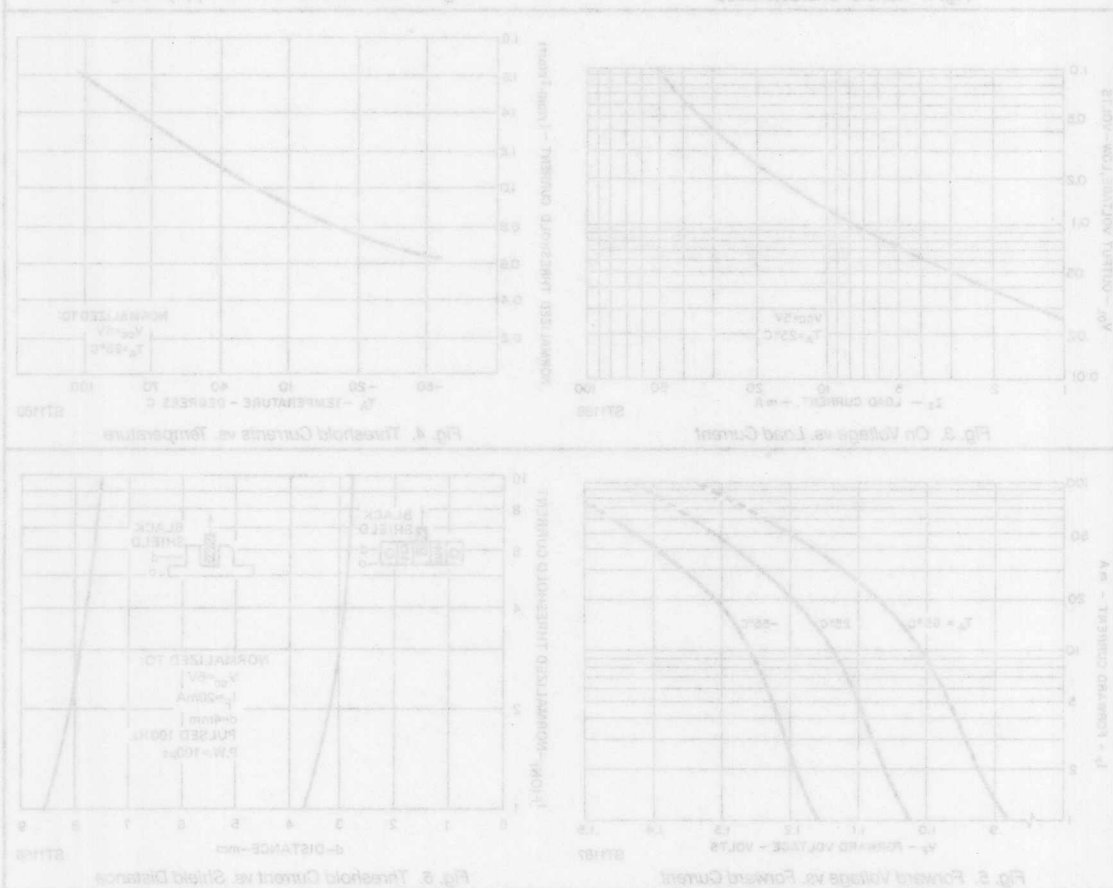
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—	—	1.6	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—	—	10	μA	$V_R = 3\text{V}$
OUTPUT OPTOLOGIC™						
Operating Voltage Range	V_C	4	—	16	V	
Supply Current	$I_{3(\text{off})}$	—	—	5.0	mA	$I_F = 0, V_{CC} = 5\text{V}$
Supply Current	$I_{3(\text{on})}$	—	—	5.0	mA	$I_F = 30\text{mA}, V_{CC} = 5\text{V}$

NOTES

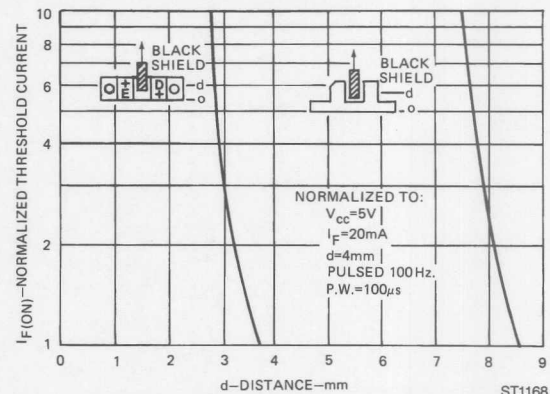
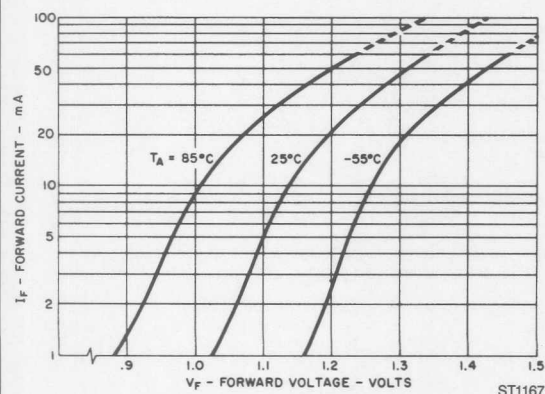
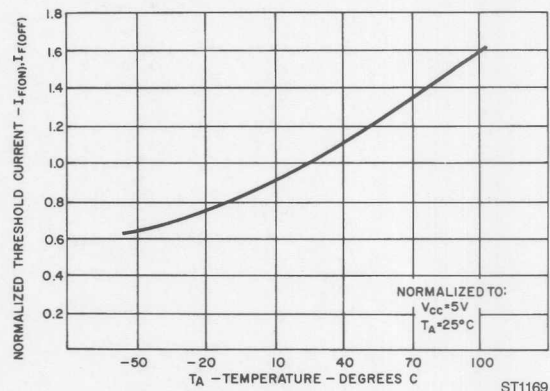
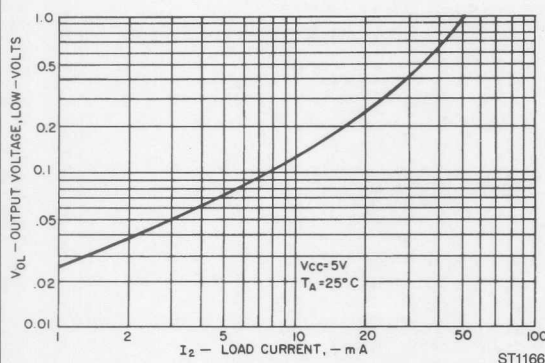
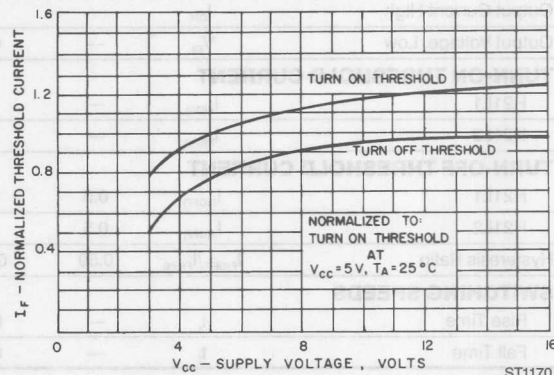
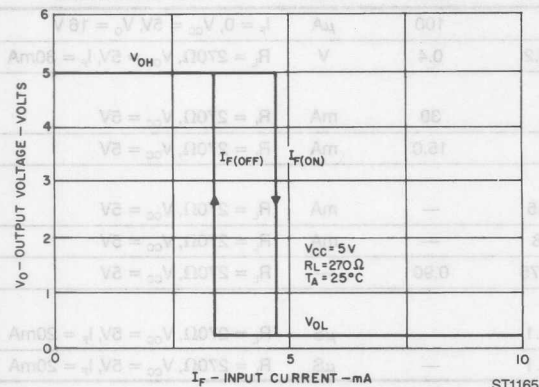
1. Derate power dissipation linearly $1.33\text{mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00\text{mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16"$ (1.6 mm) minimum from housing.

COUPLED ELECTRICAL CHARACTERISTICS

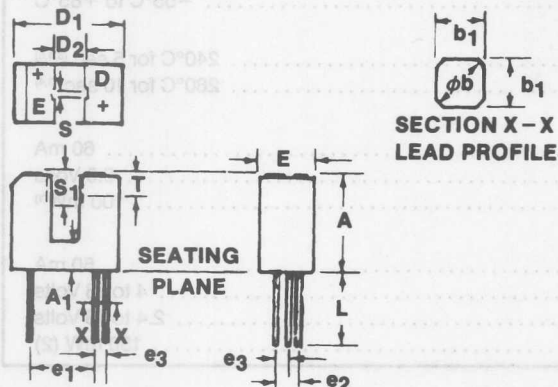
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Output Current High	I_{OH}	—	—	100	μA	$I_F = 0, V_{CC} = 5V, V_O = 16V$
Output Voltage, Low	V_{OL}	—	0.2	0.4	V	$R_L = 270\Omega, V_{CC} = 5V, I_F = 30mA$
TURN-ON THRESHOLD CURRENT						
H21L1	$I_{F(ON)}$	—	—	30	mA	$R_L = 270\Omega, V_{CC} = 5V$
H21L2	$I_{F(ON)}$	—	—	15.0	mA	$R_L = 270\Omega, V_{CC} = 5V$
TURN-OFF THRESHOLD CURRENT						
H21L1	$I_{F(OFF)}$	0.5	15	—	mA	$R_L = 270\Omega, V_{CC} = 5V$
H21L2	$I_{F(OFF)}$	0.5	8	—	mA	$R_L = 270\Omega, V_{CC} = 5V$
Hysteresis Ratio	$I_{F(OFF)}/I_{F(ON)}$	0.50	0.75	0.90	—	$R_L = 270\Omega, V_{CC} = 5V$
SWITCHING SPEEDS						
Rise Time	t_r	—	0.1	—	μS	$R_L = 270\Omega, V_{CC} = 5V, I_F = 20mA$
Fall Time	t_f	—	0.1	—	μS	$R_L = 270\Omega, V_{CC} = 5V, I_F = 20mA$



TYPICAL CHARACTERISTICS



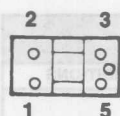
PACKAGE DIMENSIONS



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
φb	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	—	.119	—	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
e ₃	1.14	1.4	.045	.055	
E	6.15	6.35	.243	.249	
L	8.00	—	.315	—	
S	.85	1.0	.034	.039	
S ₁	3.94 NOM.		.155 NOM.		
T	2.6 NOM.		.103 NOM.		3

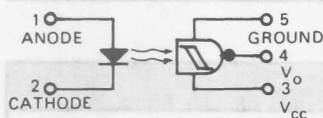
NOTES

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FIVE LEADS, LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27 mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ±0.75 mm (±.030 INCH).



ST1343

PACKAGE OUTLINE



ST1610

DESCRIPTION

The H22L Slotted Optical Switch is a gallium arsenide light emitting diode coupled to a high speed integrated circuit detector in a plastic housing. The output incorporates a Schmitt trigger which provides hysteresis for noise immunity and pulse shaping. The packaging system is designed to optimize the mechanical resolution, coupling efficiency, ambient light rejection, cost and reliability. The gap in the housing provides a means of interrupting the signal with an opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+85^\circ\text{C}$
Operating Temperature	-55°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT OPTOLOGIC™

Output Current I_4	50 mA
Allowed Range V_{35}	4 to 16 Volts
Allowed Range V_{45}	2.4 to 16 Volts
Power Dissipation	150 mW (2)

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

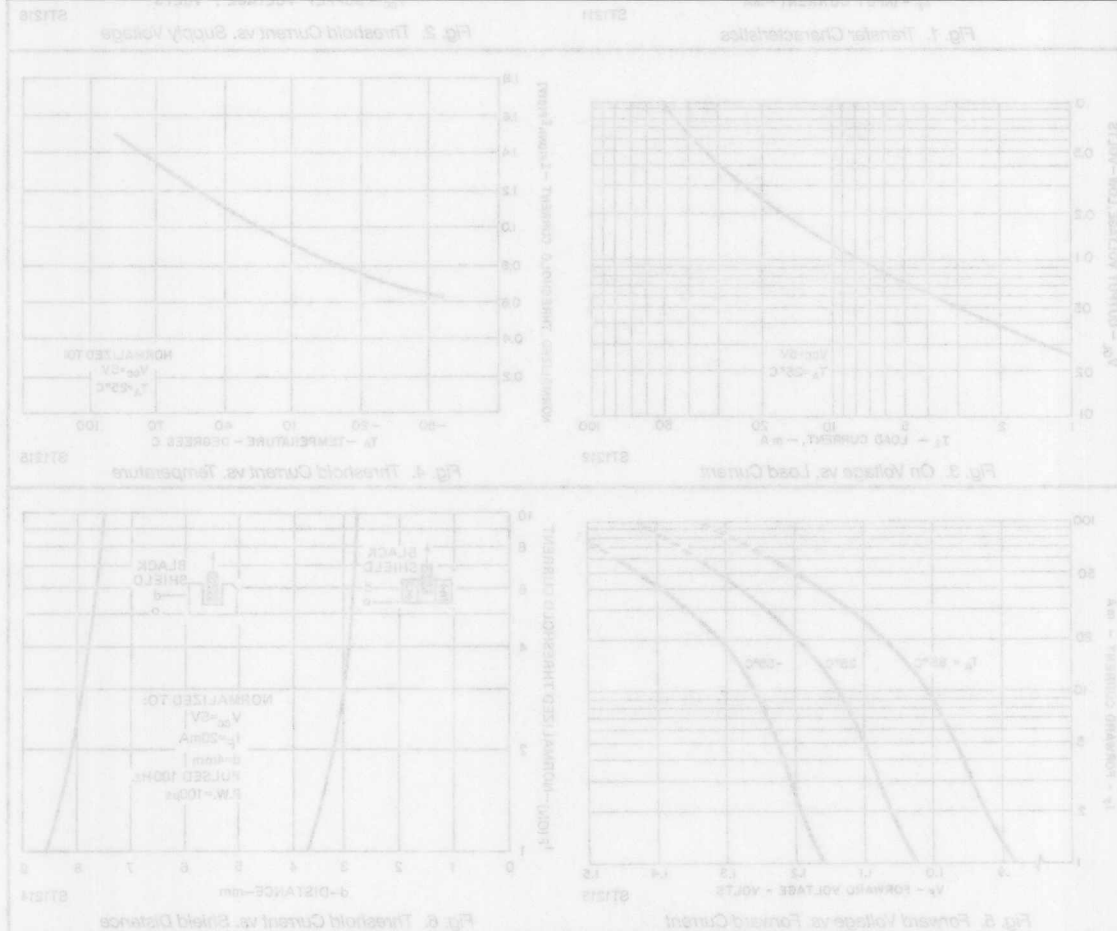
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.6	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3\text{V}$
OUTPUT OPTOLOGIC™						
Operating Supply Voltage	V_C	4		15	V	
Supply Current	$I_{3(\text{off})}$	—		5.0	mA	$I_F = 0, V_{CC} = 5\text{V}$
Supply Current	$I_{3(\text{on})}$	—		5.0	mA	$I_F = 30 \text{ mA}, V_{CC} = 5\text{V}$

NOTES

1. Derate power dissipation linearly $1.33\text{mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00\text{mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16"$ (1.6 mm) minimum from housing.

COUPLED ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Output Current High	I_{OH}	—		100	μA	$I_F = 0, V_{CC} = 5V, V_O = 16V$
Output Voltage, Low	V_{OL}	—	0.2	0.4	V	$R_L = 270\Omega, V_{CC} = 5V, I_F = 30mA$
TURN-ON THRESHOLD CURRENT						
H22L1	$I_{F(ON)}$	—	20	30	mA	$R_L = 270\Omega, V_{CC} = 5V$
H22L2	$I_{F(ON)}$	—	10	15.0	mA	$R_L = 270\Omega, V_{CC} = 5V$
TURN-OFF THRESHOLD CURRENT						
H22L1	$I_{F(OFF)}$	0.5	15	—	mA	$R_L = 270\Omega, V_{CC} = 5V$
H22L2	$I_{F(OFF)}$	0.5	8	—	mA	$R_L = 270\Omega, V_{CC} = 5V$
Hysteresis Ratio	$I_{F(OFF)}/I_{F(ON)}$	0.50	0.75	0.90	—	$R_L = 270\Omega, V_{CC} = 5V$
SWITCHING SPEEDS						
Rise Time	t_r	—	0.1	—	μS	$R_L = 270\Omega, V_{CC} = 5V, T_A = 25^\circ C, I_F = 20mA$
Fall Time	t_f	—	0.1	—	μS	$R_L = 270\Omega, V_{CC} = 5V, T_A = 25^\circ C, I_F = 20mA$



TYPICAL CHARACTERISTICS

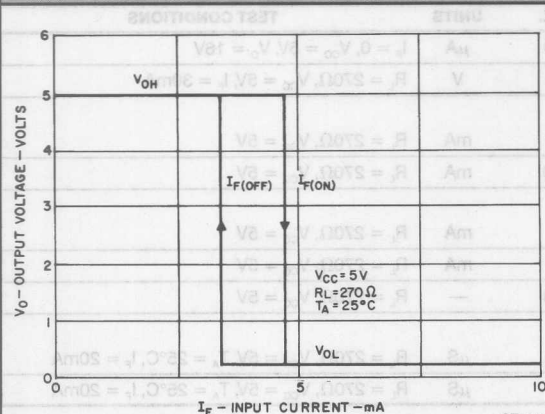


Fig. 1. Transfer Characteristics

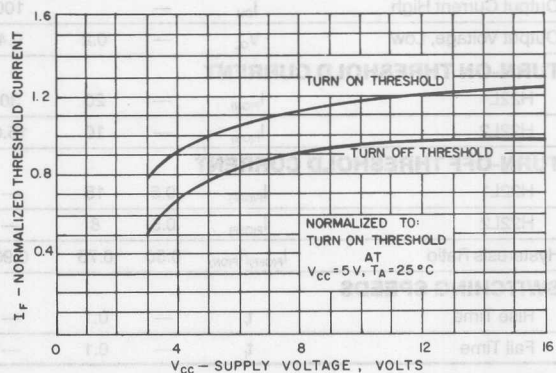


Fig. 2. Threshold Current vs. Supply Voltage

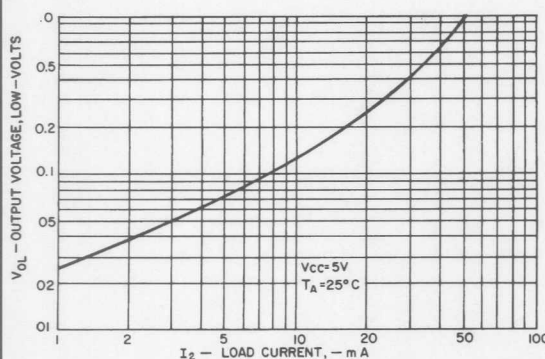


Fig. 3. On Voltage vs. Load Current

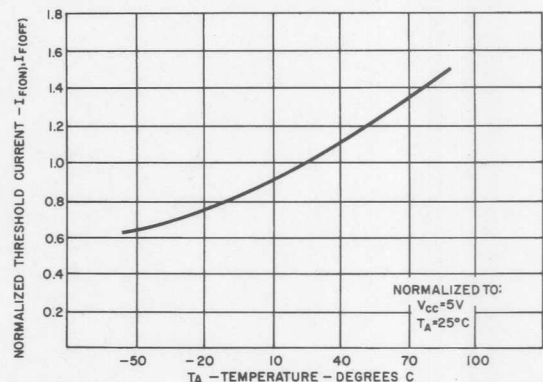


Fig. 4. Threshold Current vs. Temperature

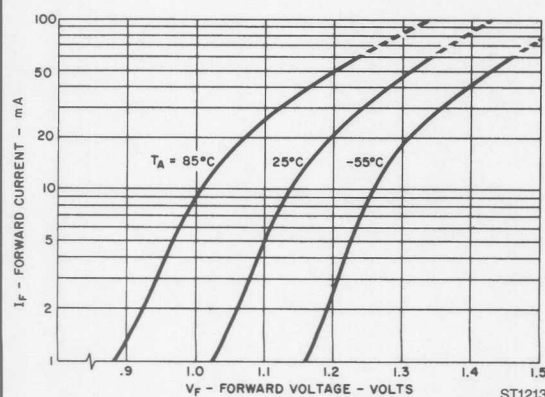


Fig. 5. Forward Voltage vs. Forward Current

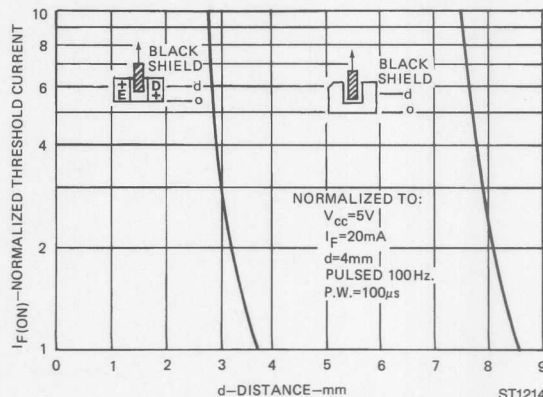
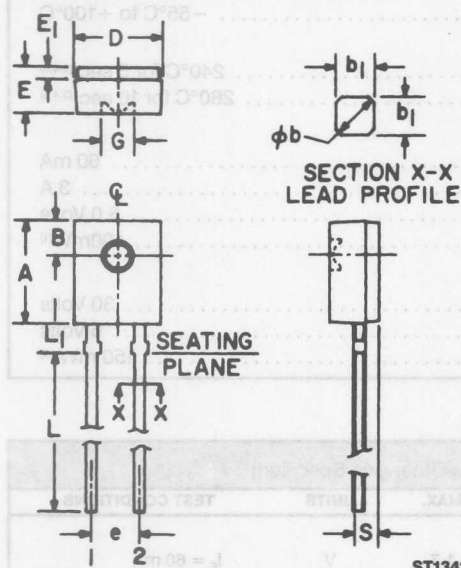


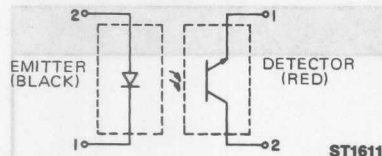
Fig. 6. Threshold Current vs. Shield Distance

PACKAGE DIMENSIONS



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
ϕb	.60	.75	.024	.030	1
b_1	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E_1	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L_1	1.40	1.65	.055	.065	
S	.83	.94	.033	.037	3

PACKAGE OUTLINE



NOTES

1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27 mm (0.50") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25 mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

DESCRIPTION

The H23A is a matched emitter-detector pair which consists of a gallium arsenide infrared emitting diode and a silicon phototransistor. The clear epoxy packaging system is designed to optimize the mechanical resolution, coupling efficiency, cost, and reliability. The devices are marked with a color dot for easy identification of the emitter and detector.

FEATURES

- Good optical to mechanical alignment
- Color dot for easy recognition of LED and phototransistor
- Low cost

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4,5)

INPUT DIODE

Continuous Forward Current	60 mA
Forward Current (pw, $1\mu\text{s}$; 33 Hz)	3 A
Reverse Voltage	6.0 Volts
Power Dissipation	100mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	6 Volts
Power Dissipation	150 mW ⁽²⁾

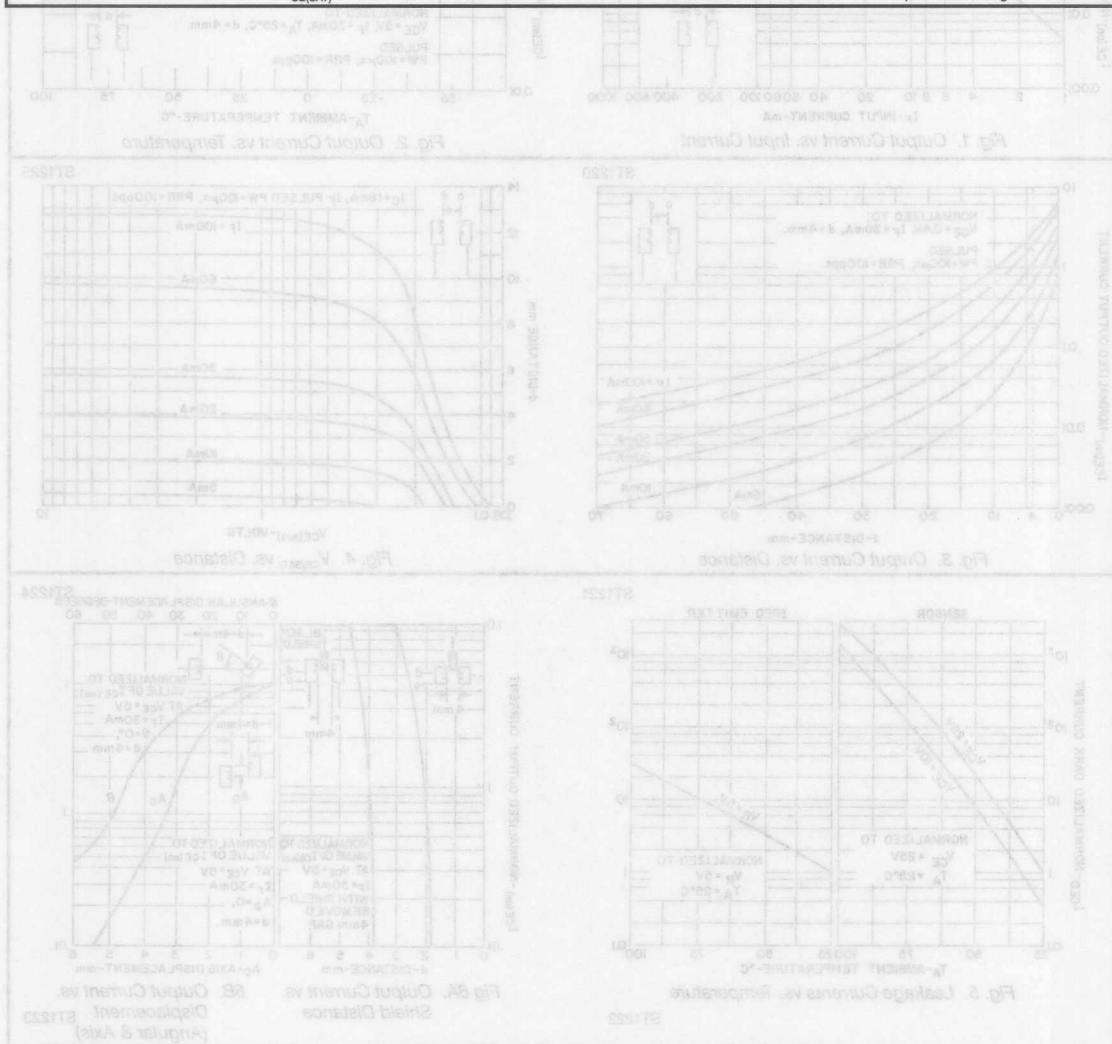
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 60\text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 6\text{ V}$
Reverse Breakdown Voltage	BV_R	6.0		—	V	$I_R = 10\mu\text{A}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	6.0		—	V	$I_E = 100\mu\text{A}$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 10\text{ mA}$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10\text{ V}$
COUPLED						
On-State Collector Current	$I_{C(ON)}$		See page 3.			
Saturation Voltage	$V_{CE(SAT)}$		See page 3.			
Turn-On Time	t_{on}		150		μS	$I_F = 30\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 2.5\text{ K}\Omega$
Turn-Off Time	t_{off}		150		μS	$I_F = 30\text{ mA}$, $V_{CC} = 5\text{ V}$, $R_L = 2.5\text{ K}\Omega$

NOTES

1. Derate power dissipation linearly $1.33\text{mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00\text{mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
6. Coupled characteristics are measured at a separation distance of .155" (4 mm) with the lenses of the emitter and detector on a common axis within 0.1mm and parallel within 5° .

$I_{C(ON)}$ and $V_{CE(SAT)}$ TABLE						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
ON-STATE COLLECTOR CURRENT						
H23A1	$I_{C(ON)}$	1.5	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$ ⁽⁶⁾
H23A2	$I_{C(ON)}$	0.5	—	—	mA	$I_F = 30\text{mA}$, $V_{CE} = 5\text{V}$ ⁽⁶⁾
SATURATION VOLTAGE						
H23A1	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 30\text{mA}$, $I_C = 1.0\text{mA}$ ⁽⁶⁾
H23A2	$V_{CE(SAT)}$	—	—	0.40	V	$I_F = 30\text{mA}$, $I_C = .4\text{mA}$ ⁽⁶⁾



TYPICAL CHARACTERISTICS

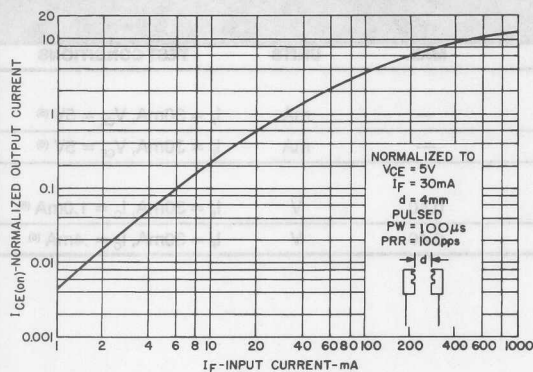


Fig. 1. Output Current vs. Input Current

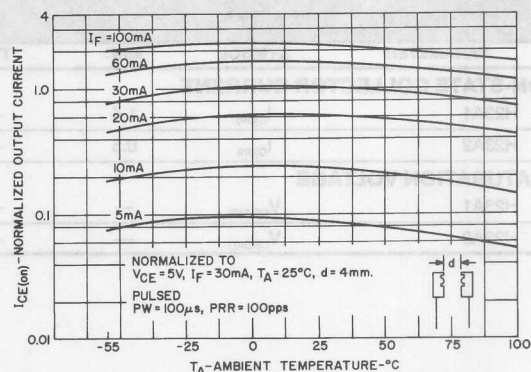


Fig. 2. Output Current vs. Temperature

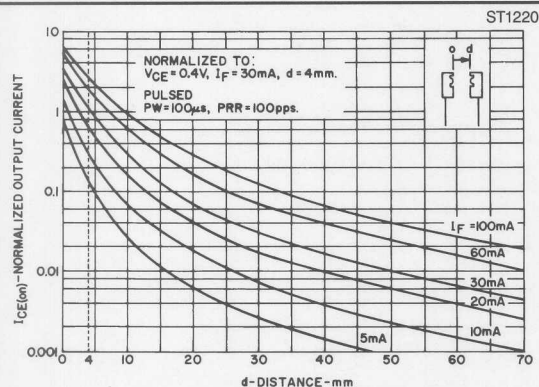


Fig. 3. Output Current vs. Distance

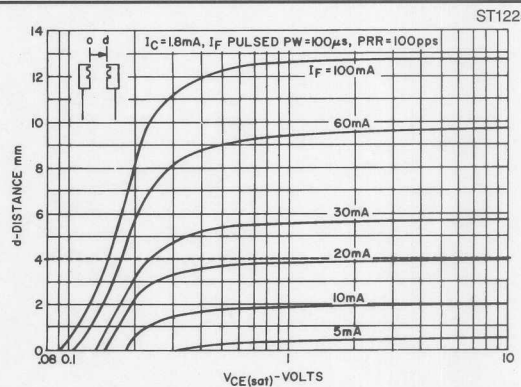


Fig. 4. $V_{CE(SAT)}$ vs. Distance

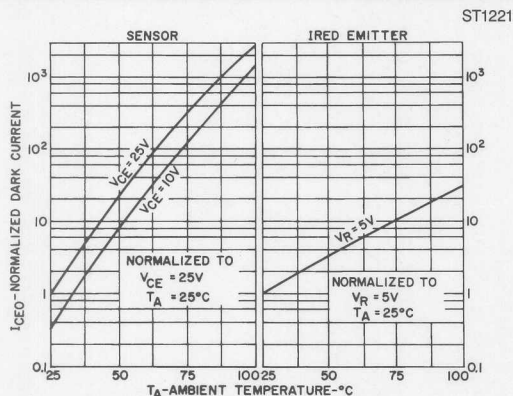


Fig. 5. Leakage Currents vs. Temperature

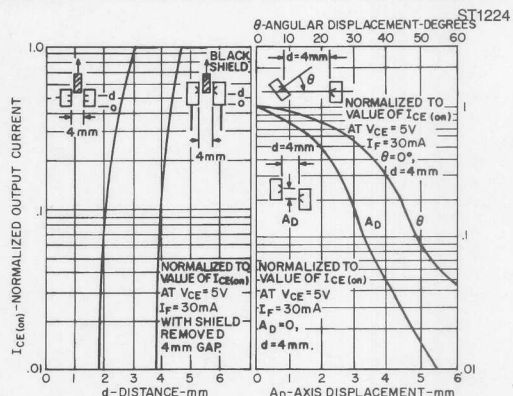
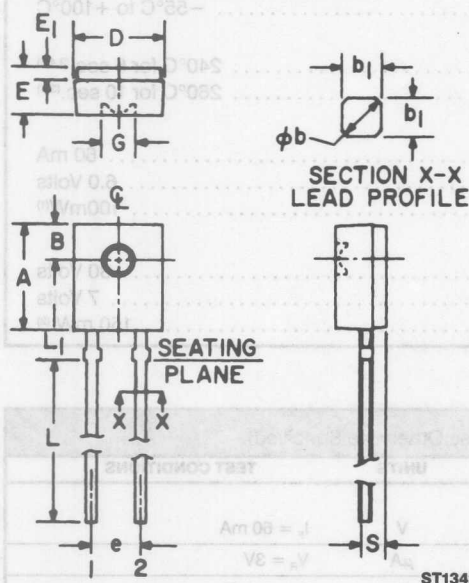


Fig 6A. Output Current vs. Shield Distance

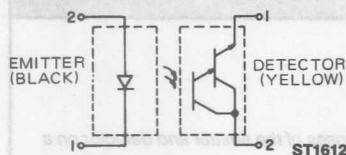
6B. Output Current vs. Displacement (Angular & Axis)

PACKAGE DIMENSIONS



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
ϕb	.60	.75	.024	.030	1
b ₁	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E ₁	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L ₁	1.40	1.65	.055	.065	
S	.83	.94	.033	.037	3

PACKAGE OUTLINE



NOTES

1. TWO LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27 mm (0.050") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25 mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

DESCRIPTION

The H23B1 is a matched emitter-detector pair which consists of a gallium arsenide infrared emitting diode and a silicon photodarlington. The clear epoxy packaging system is designed to optimize the mechanical resolution, coupling efficiency, cost, and reliability. The devices are marked with a color dot for easy identification of the emitter and detector.

FEATURES

- Good optical to mechanical alignment
- Color dot for easy recognition of LED and phototransistor
- Low cost

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+100^\circ\text{C}$
Operating Temperature	-55°C to $+100^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	7 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—	1.7	—	V	$I_F = 60 \text{ mA}$
Reverse Leakage Current	I_R	—	1.0	—	μA	$V_R = 3 \text{ V}$
Reverse Breakdown Voltage	V_R	6.0	—	—	V	$I_R = 10 \mu\text{A}$
OUTPUT DARLINGTON						
Emitter-Collector Breakdown	BV_{ECO}	7.0	—	—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30	—	—	V	$I_C = 1 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—	100	—	nA	$V_{CE} = 25 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	7.5	—	—	mA	$I_F = 10 \text{ mA}$, $V_{CE} = 1.5 \text{ V}$ ⁽⁶⁾
Saturation Voltage	$V_{CE(SAT)}$	—	1.0	—	V	$I_F = 10 \text{ mA}$, $I_C = 1.8 \text{ mA}$ ⁽⁶⁾
Turn-On Time	t_{on}	—	8	—	μs	$I_F = 30 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 2.5 \text{ K}\Omega$ ⁽⁶⁾
Turn-Off Time	t_{off}	—	50	—	μs	$I_F = 30 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 2.5 \text{ K}\Omega$ ⁽⁶⁾

NOTES

1. Derate power dissipation linearly $1.33 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) minimum from housing.
6. Coupled characteristics are measured at a separation distance of .155" (4 mm) with the lenses of the emitter and detector on a common axis within 0.1mm and parallel within 5° .

TYPICAL CHARACTERISTICS

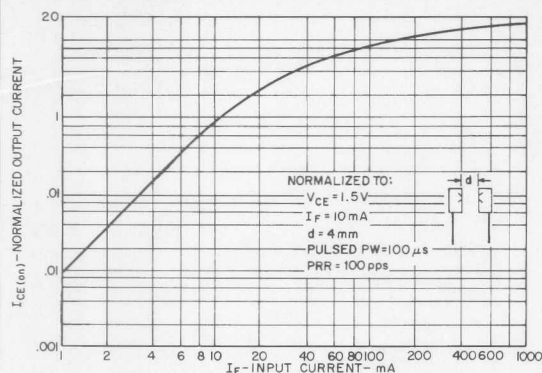


Fig. 1. Output Current vs. Input Current

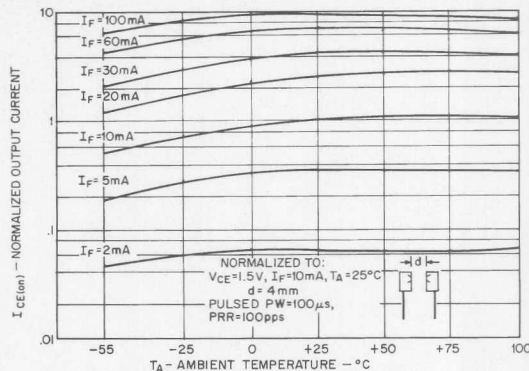


Fig. 2. Output Current vs. Temperature

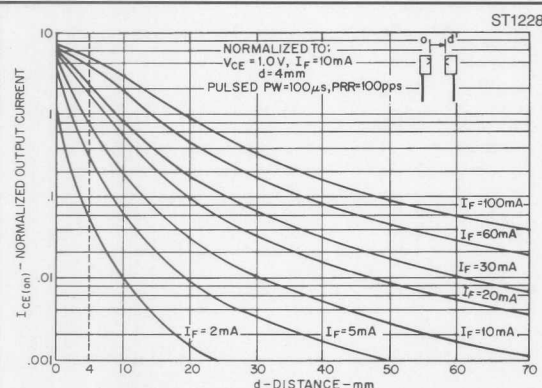


Fig. 3. Output Current vs. Distance

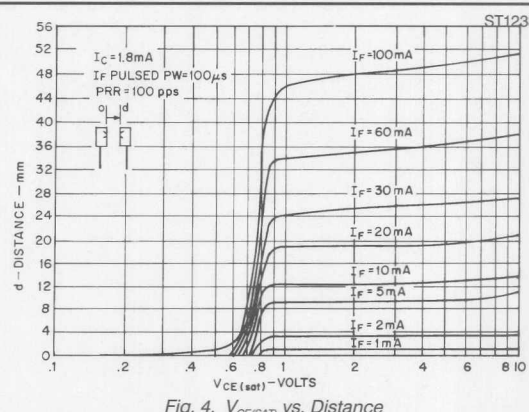


Fig. 4. $V_{CE(SAT)}$ vs. Distance

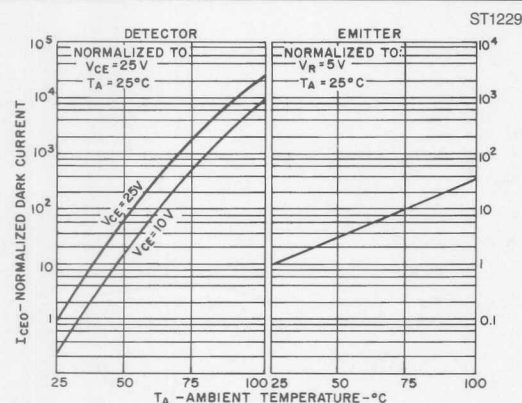


Fig. 5. Leakage Currents vs. Temperature

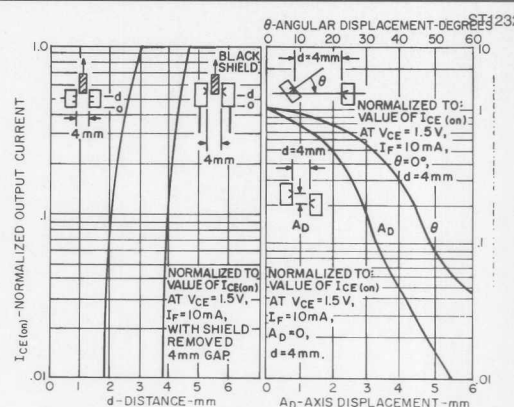


Fig 6A. Output Current vs. Shield Distance

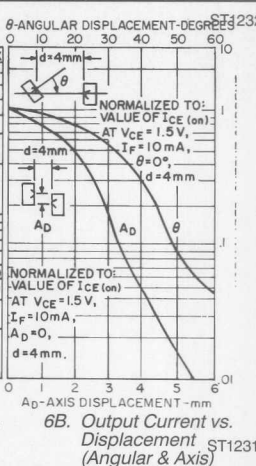


Fig 6B. Output Current vs. Displacement (Angular & Axis)

TYPICAL CHARACTERISTICS

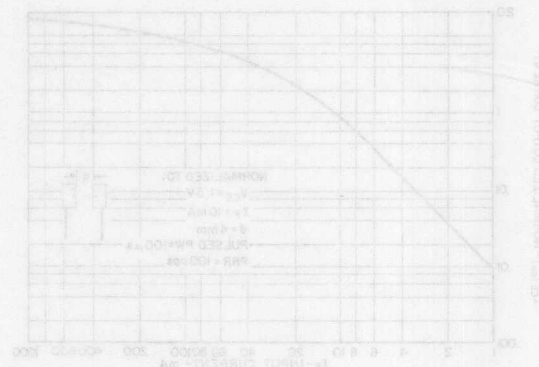


Fig. 1. Output Current vs. Input Current

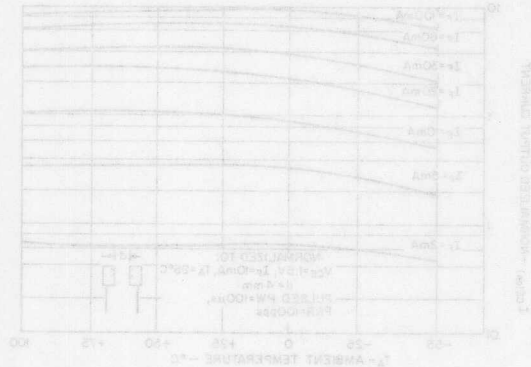


Fig. 2. Output Current vs. Temperature

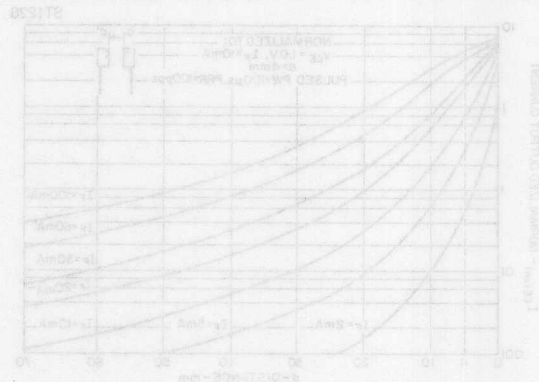


Fig. 3. Output Current vs. Distance

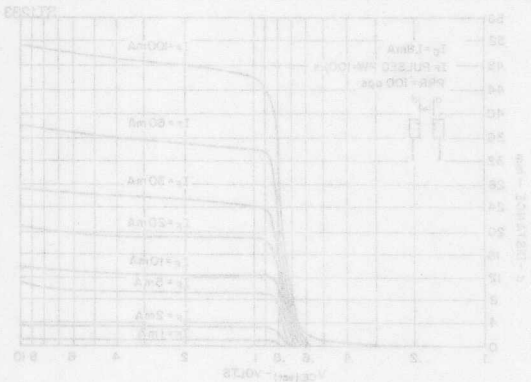


Fig. 4. Output Current vs. Distance



Fig. 5. Output Current vs. Temperature

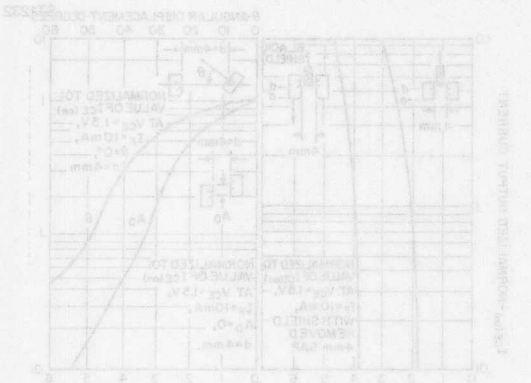
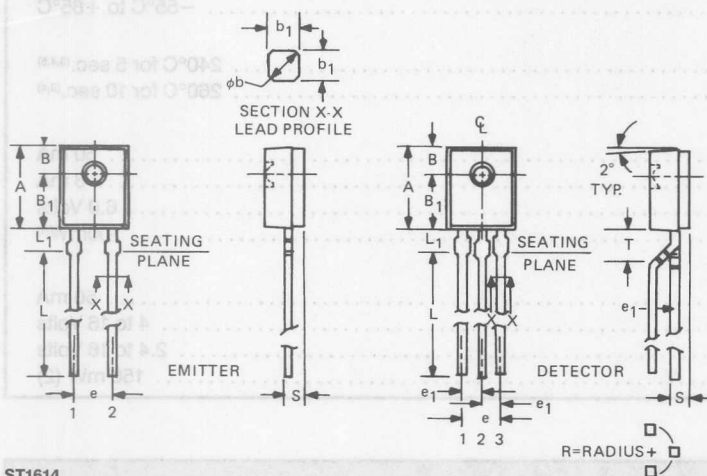


Fig. 6. Output Current vs. Distance

PACKAGE DIMENSIONS



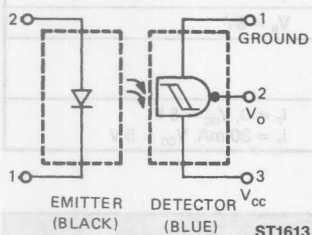
SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	5.59	5.80	.220	.228	
B	1.78	NOM.	.070	NOM.	2
B ₁	3.68	3.94	.145	.155	
φb	.60	.75	.024	.030	1
b ₁	.51	NOM.	.020	NOM.	1
D	4.45	4.70	.175	.185	
E	2.41	2.67	.095	.105	
E ₁	.58	.69	.023	.027	
e	2.41	2.67	.095	.105	3
e ₁	1.14	1.40	.045	.055	3
G	1.98	NOM.	.078	NOM.	
L	12.7	—	.500	—	
L ₁	1.40	1.65	.055	.065	1
R	1.27	NOM.	.050	NOM.	
S	.83	.94	.033	.037	3
T	—	1.65	—	.065	

NOTES

1. LEADS. LEAD CROSS SECTION DIMENSIONS UNCONTROLLED WITHIN 1.27 mm (0.50") OF SEATING PLANE.
2. CENTERLINE OF ACTIVE ELEMENT LOCATED WITHIN .25 mm (.010") OF TRUE POSITION.
3. AS MEASURED AT THE SEATING PLANE.
4. INCH DIMENSIONS DERIVED FROM MILLIMETERS.

ST1614

PACKAGE OUTLINE



EMITTER (BLACK) DETECTOR (BLUE) ST1613

DESCRIPTION

The H23L1 is a matched emitter-detector pair which consists of a gallium arsenide infrared light emitting diode and a high speed integrated circuit detector. The output incorporates a Schmitt trigger which provides hysteresis for noise immunity and pulse shaping. The detector circuit is optimized for simplicity of operation and utilizes an open collector output for maximum application flexibility. The clear epoxy packaging system is designed to optimize the mechanical resolution, coupling efficiency, cost, and reliability. The devices are marked with a color dot for easy identification of the emitter and detector.

FEATURES

- Good optical to mechanical alignment
- Color dot for easy recognition of LED and detector
- Low cost

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+85^\circ\text{C}$
Operating Temperature	-55°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Continuous Forward Current	3 mA
Reverse Voltage	6.0 Volts
Power Dissipation	100mW ⁽¹⁾

OUTPUT OPTOLOGIC™

Output Current I_2	50 mA
Allowed Range V_{CC}	4 to 16 Volts
Allowed Range V_{21}	2.4 to 16 Volts
Power Dissipation	150 mW (2)

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

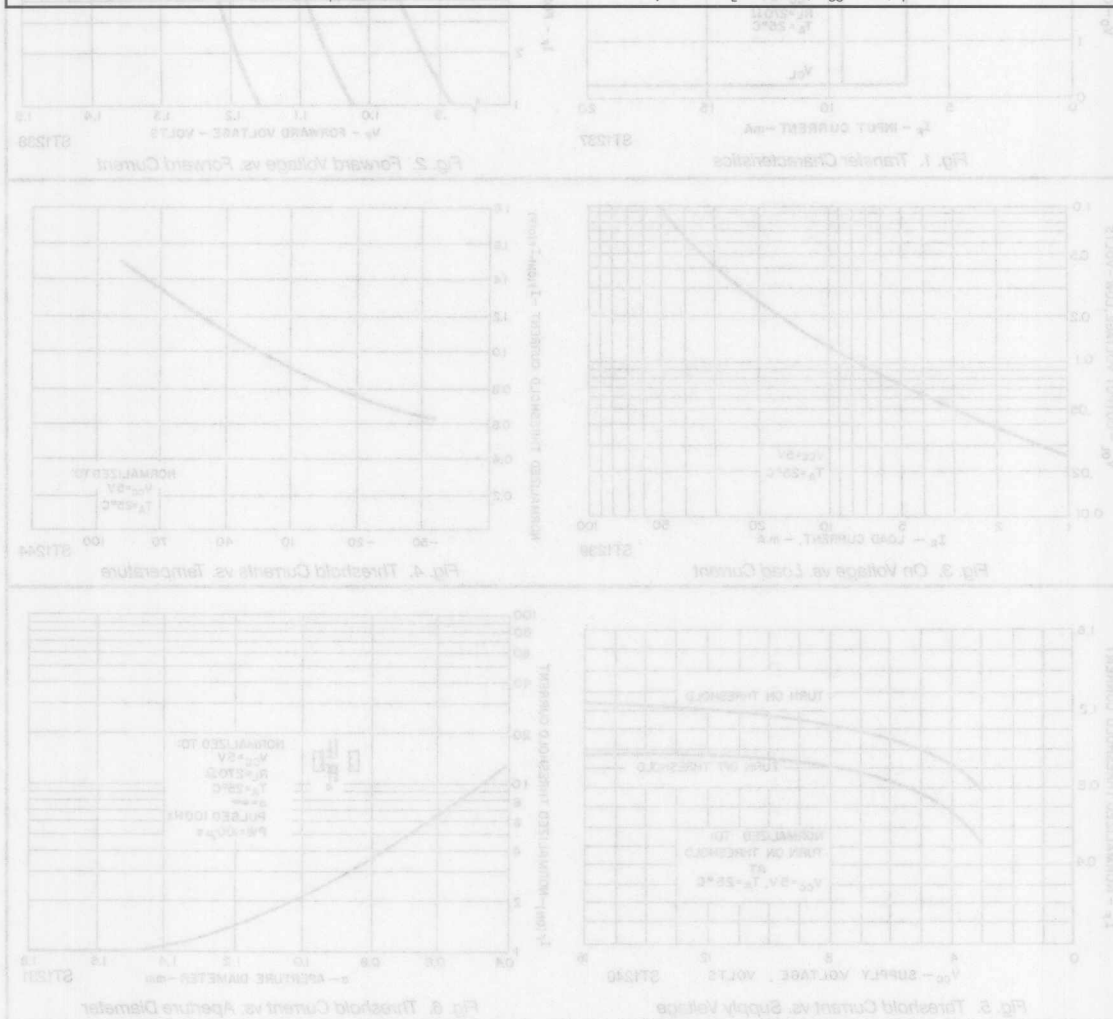
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.5	V	$I_F = 20 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 3\text{V}$
OUTPUT OPTOLOGIC™						
Operating Supply Voltage	V_{CC}	4		16	V	
Supply Current	$I_{3(\text{off})}$	—		5.0	mA	$I_F = 0, V_{CC} = 5 \text{ V}$
Supply Current	$I_{3(\text{on})}$	—		5.0	mA	$I_F = 30 \text{ mA}, V_{CC} = 5 \text{ V}$

NOTES

1. Derate power dissipation linearly $1.33\text{mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.00\text{mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $1/16"$ (1.6 mm) from housing.
6. Coupled characteristics are measured at a separation distance of .155" (4 mm) with the lens of the emitter and detector on a common axis within 0.1 mm and parallel within 5° .

COUPLED ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Output Current High	I_{OH}	—	—	100	μA	$I_F = 0, V_{CC} = 5V, V_O = 16V$
Output Voltage, Low	V_{OL}	—	0.2	0.4	V	$R_L = 270\Omega, V_{CC} = 5V, I_F = 20 mA$
Turn-On Threshold Current	$I_{F(ON)}$	—	10.0	20.0	mA	$R_L = 270\Omega, V_{CC} = 5V$
Turn-Off Threshold Current	$I_{F(OFF)}$	1.0	7.5	—	mA	$R_L = 270\Omega, V_{CC} = 5V$
Hysteresis Ratio	$I_{F(OFF)}/I_{F(ON)}$	0.50	0.75	0.90	—	$R_L = 270\Omega, V_{CC} = 5V$
SWITCHING SPEEDS						
Rise Time	t_r	—	0.1	—	μS	$R_L = 270\Omega, V_{CC} = 5V, I_F = 20 mA$
Fall Time	t_f	—	0.1	—	μS	$R_L = 270\Omega, V_{CC} = 5V, I_F = 20 mA$



TYPICAL CHARACTERISTICS

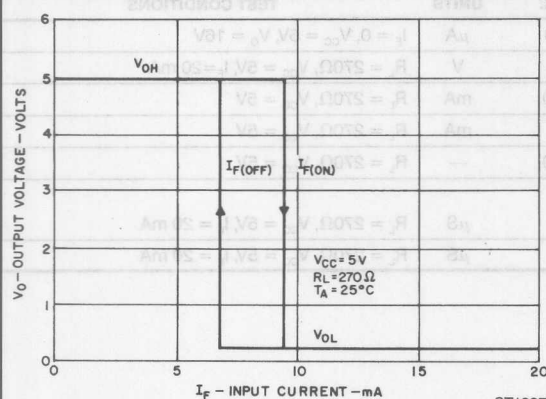


Fig. 1. Transfer Characteristics

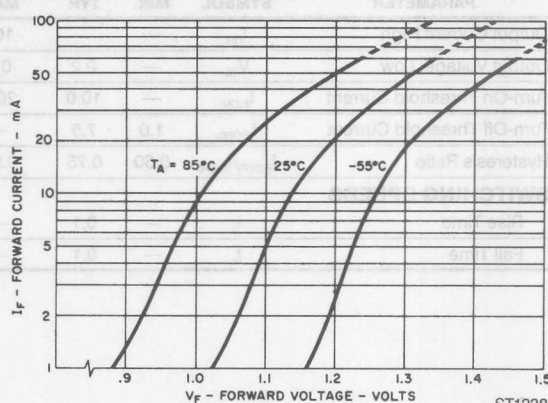


Fig. 2. Forward Voltage vs. Forward Current

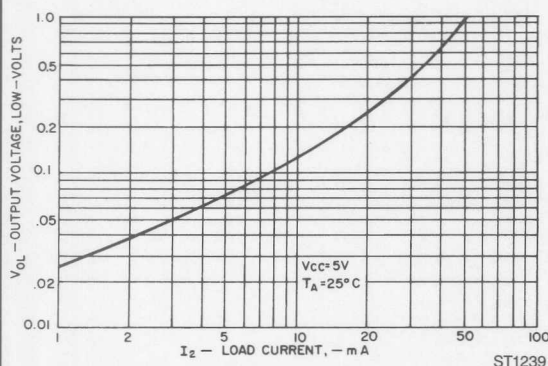


Fig. 3. On Voltage vs. Load Current

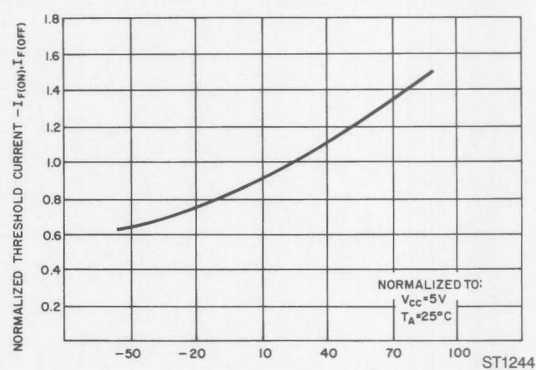


Fig. 4. Threshold Currents vs. Temperature

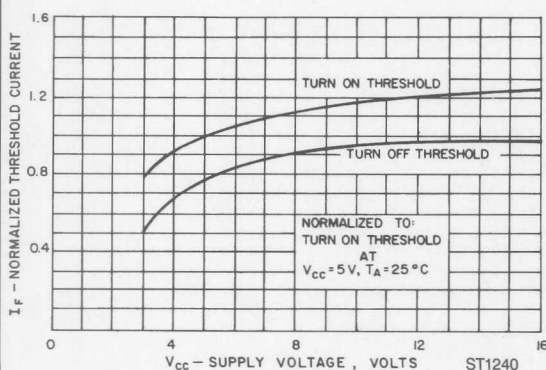


Fig. 5. Threshold Current vs. Supply Voltage

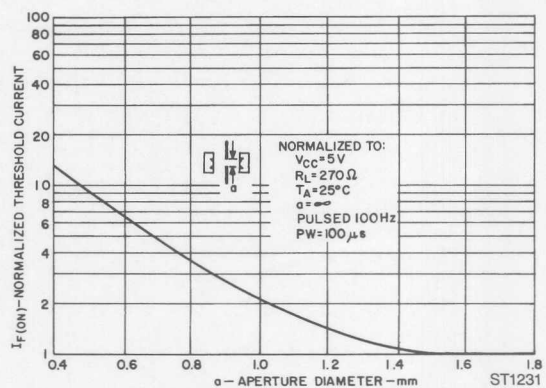


Fig. 6. Threshold Current vs. Aperture Diameter

TYPICAL CHARACTERISTICS

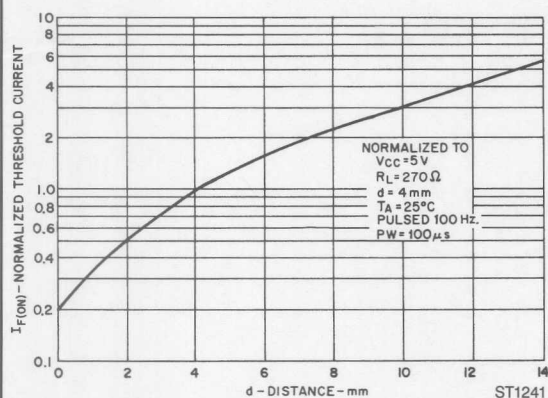


Fig. 7. Threshold Current vs. Distance

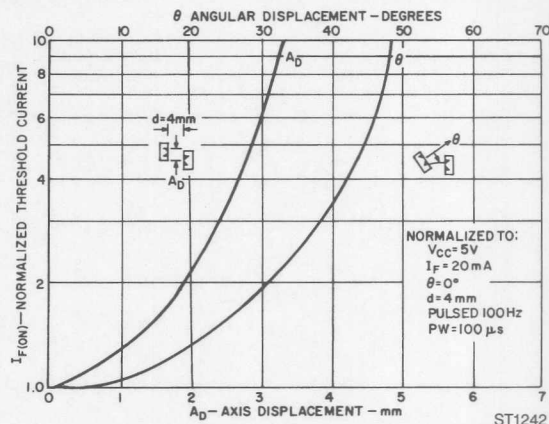


Fig. 8. Threshold Current vs. Displacement (Angular and Axis)

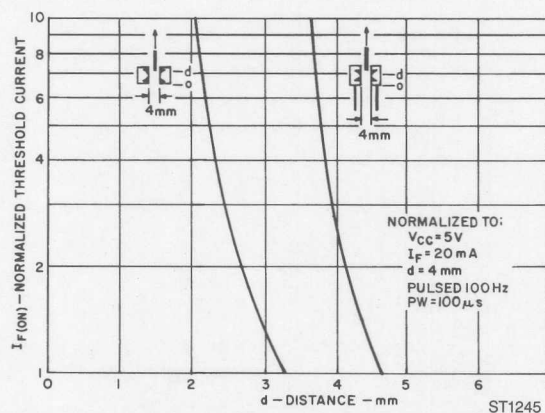
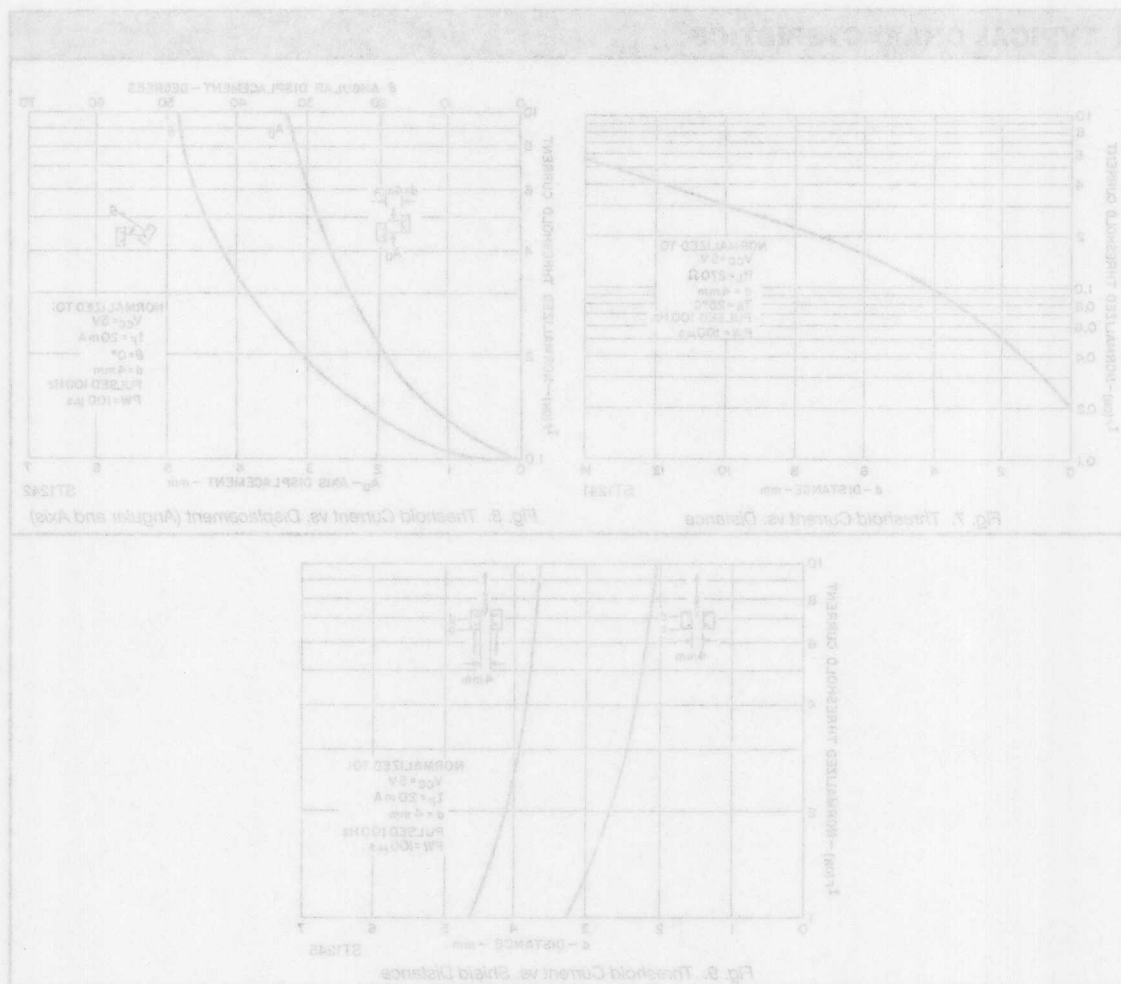
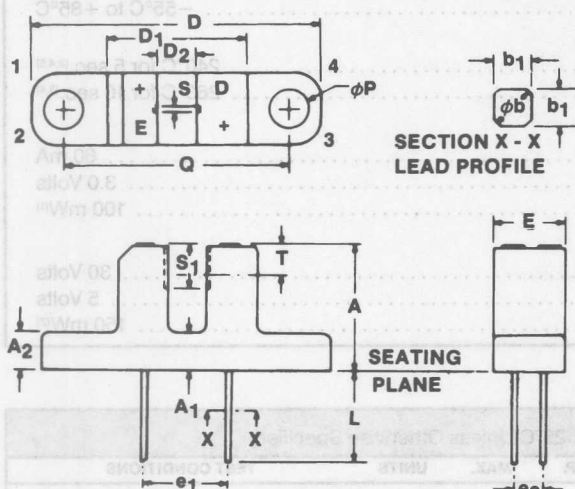


Fig. 9. Threshold Current vs. Shield Distance

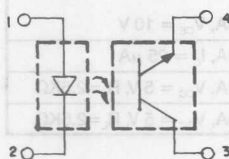


PACKAGE DIMENSIONS



SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
A ₂	3.0	3.2	.119	.125	
phi b	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D	24.3	24.7	.957	.972	
D ₁	11.0	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	.615	6.35	.243	.249	
L	6.00		.315		
phi p	3.2	3.4	.126	.133	
Q	18.9	19.2	.745	.755	
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

PACKAGE OUTLINE



ST1609

DESCRIPTION

The CNY28 is a gallium arsenide infrared emitting diode coupled with a silicon phototransistor in a plastic housing. The gap in the housing provides a means of interrupting the signal with tape, cards, shaft encoders, or other opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- European "Pro Electron" registered

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ± 0.75 mm ($\pm .030$ INCH).

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C Unless Otherwise Specified)

Storage Temperature	-55°C to +85°C
Operating Temperature	-55°C to +85°C
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	3.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V _F	—		1.7	V	I _F = 10 mA
Reverse Leakage Current	I _R	—		10	μA	V _R = 2 V
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV _{ECO}	5.0		—	V	I _E = 100 μA, Ee=0
Collector-Emitter Breakdown	BV _{CEO}	30		—	V	I _C = 10 mA, Ee=0
Collector-Emitter Leakage	I _{CEO}	—		100	nA	V _{CE} = 10 V, Ee=0
COUPLED						
On-State Collector Current	I _{C(ON)}	0.20		—	mA	I _F = 20 mA, V _{CE} = 10 V
Saturation Voltage	V _{CE(SAT)}	—		0.40	V	I _F = 20 mA, I _C = 25 μA
Turn-On Time	t _{on}		5		μS	I _F = 30 mA, V _{CC} = 5 V, R _L = 2.5KΩ
Turn-Off Time	t _{off}		5		μS	I _F = 30 mA, V _{CC} = 5 V, R _L = 2.5KΩ

NOTES

1. Derate power dissipation linearly 1.67 mW/°C above 25°C.
2. Derate power dissipation linearly 2.50 mW/°C above 25°C.
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6 mm) from housing.

TYPICAL CHARACTERISTICS

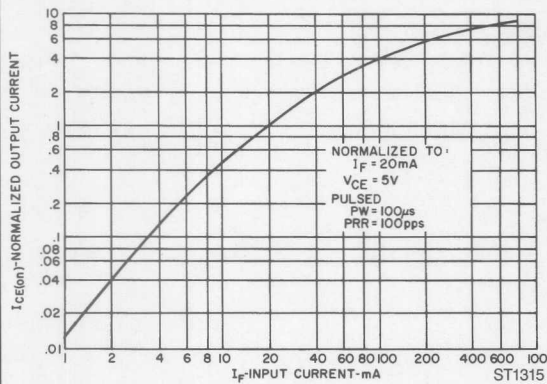


Fig. 1. Output Current vs. Input Current

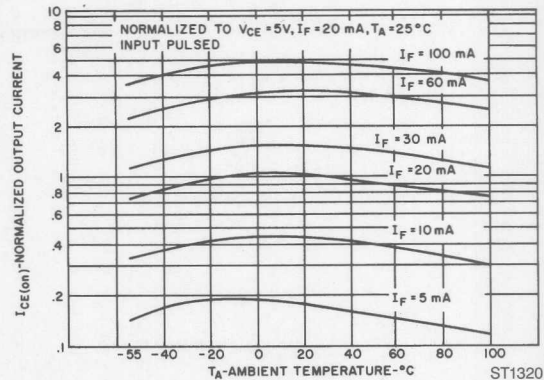


Fig. 2. Output Current vs. Temperature

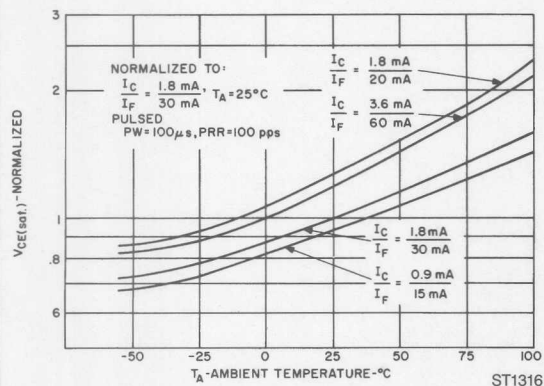


Fig. 3. $V_{CE(SAT)}$ vs. Temperature

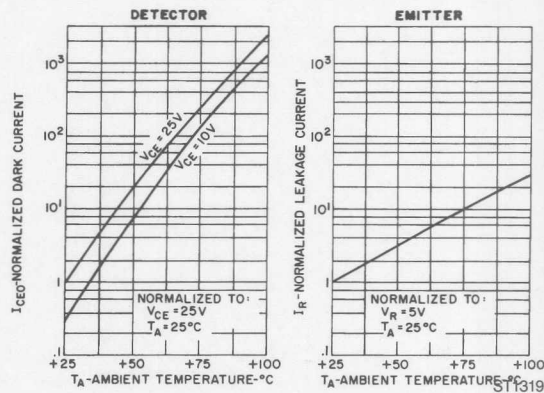


Fig. 4. Leakage Current vs. Temperature

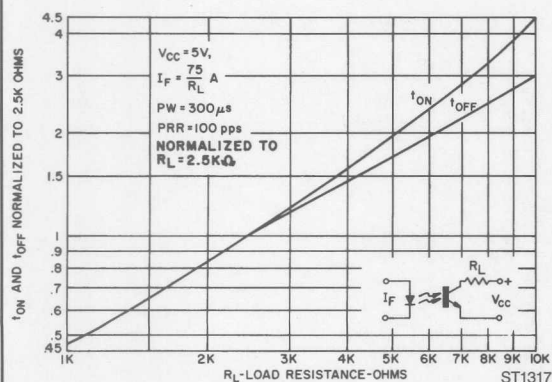


Fig. 5. Switching Speed vs. R_L

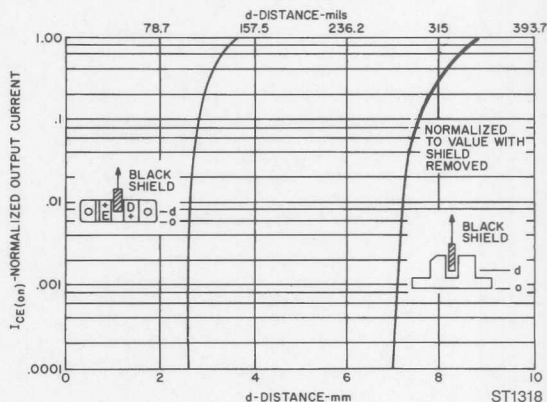
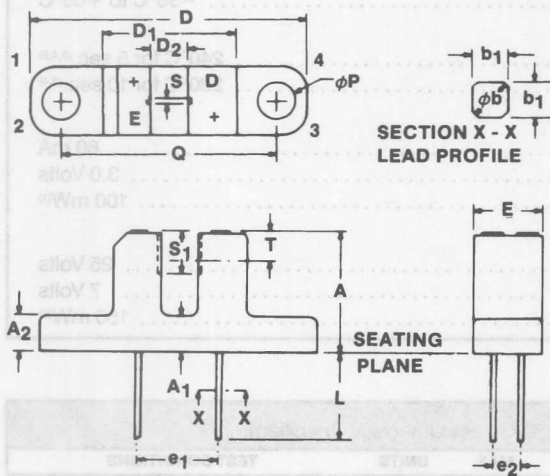


Fig. 6. Output Current vs. Distance

PACKAGE DIMENSIONS

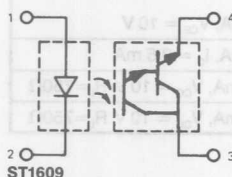


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
A ₂	3.0	3.2	.119	.125	
phi b	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D	24.3	24.7	.957	.972	
D ₁	11.0	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	.615	6.35	.243	.249	
L	6.00		.315		
phi p	3.2	3.4	.126	.133	
Q	18.9	19.2	.745	.755	
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" ± 0.75 mm ($\pm .030$ INCH).

PACKAGE OUTLINE



DESCRIPTION

The CNY29 is a gallium arsenide infrared emitting diode coupled with a silicon photodarlington in a plastic housing. The gap in the housing provides a means of interrupting the signal with tape, cards, shaft encoders, or other opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- European "Pro Electron" registered

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+85^\circ\text{C}$
Operating Temperature	-55°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	3.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT DARLINGTON

Collector-Emitter Voltage	25 Volts
Emitter-Collector Voltage	7 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 10 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 2 \text{ V}$
OUTPUT DARLINGTON						
Emitter-Collector Breakdown	BV_{ECO}	7.0		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	25		—	V	$I_C = 10 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	2.5		—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 10 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		1.2	V	$I_F = 20 \text{ mA}$, $I_C = 0.5 \text{ mA}$
Turn-On Time	t_{on}		150		μS	$I_C = 2.0 \text{ mA}$, $V_{CC} = 10 \text{ V}$, $R_L = 750\Omega$
Turn-Off Time	t_{off}		150		μS	$I_C = 2.0 \text{ mA}$, $V_{CC} = 10 \text{ V}$, $R_L = 750\Omega$

NOTES

1. Derate power dissipation linearly $1.67 \text{ mW}/^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly $2.50 \text{ mW}/^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}"$ (1.6 mm) from housing.

TYPICAL CHARACTERISTICS

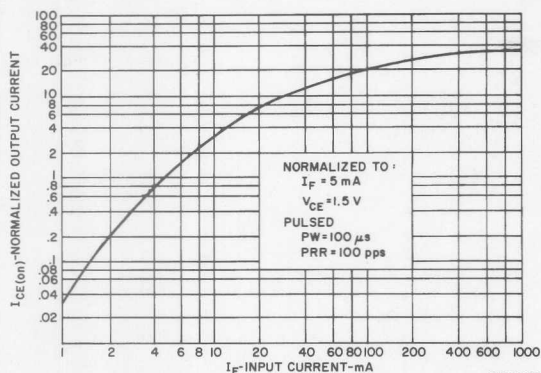


Fig. 1. Output Current vs. Input Current

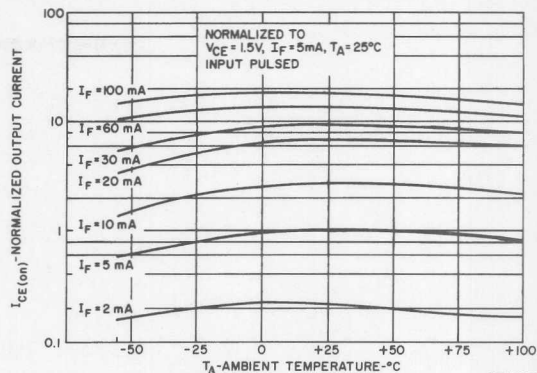


Fig. 2. Output Current vs. Temperature

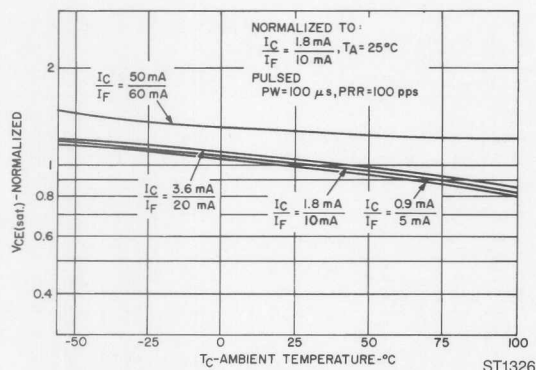


Fig. 3. $V_{CE(sat)}$ vs. Temperature

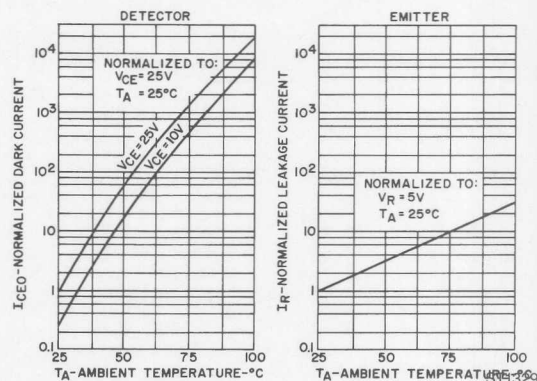


Fig. 4. Leakage Current vs. Temperature

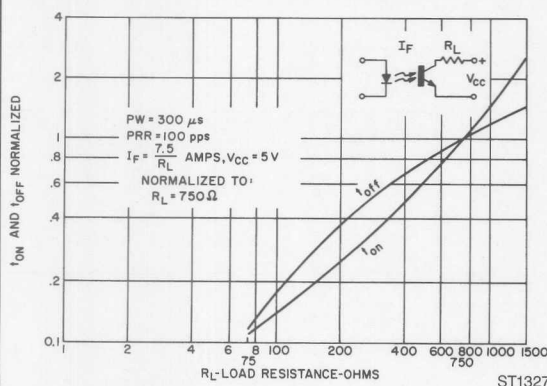


Fig. 5. Switching Speed vs. R_L

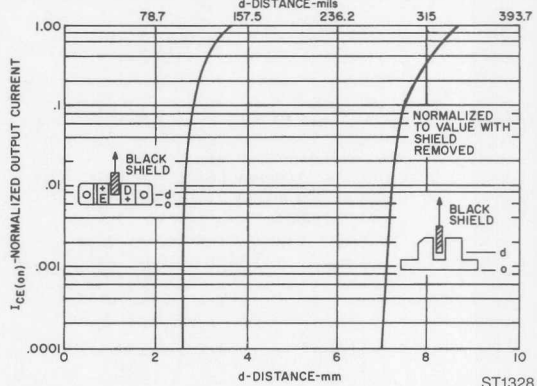
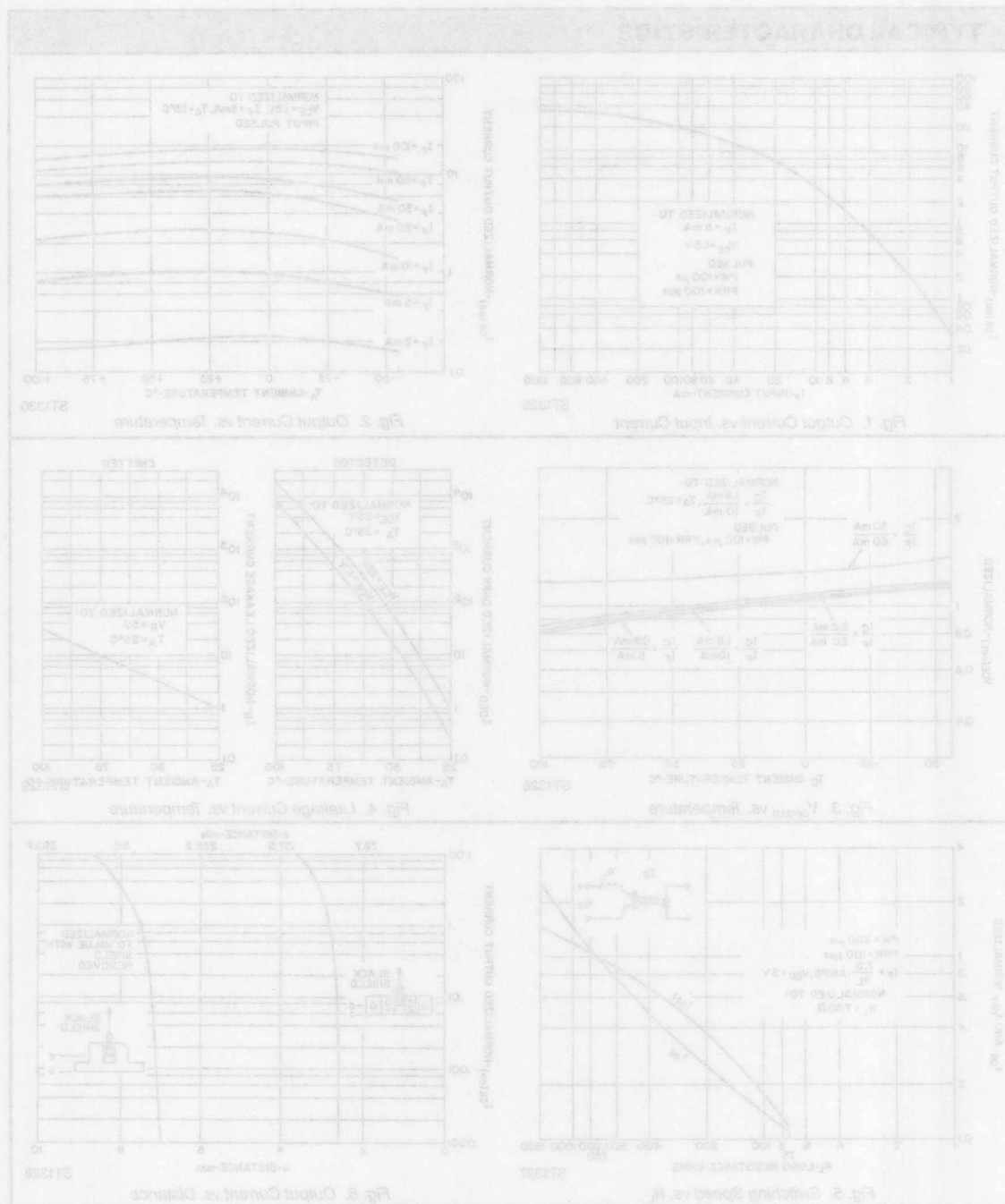
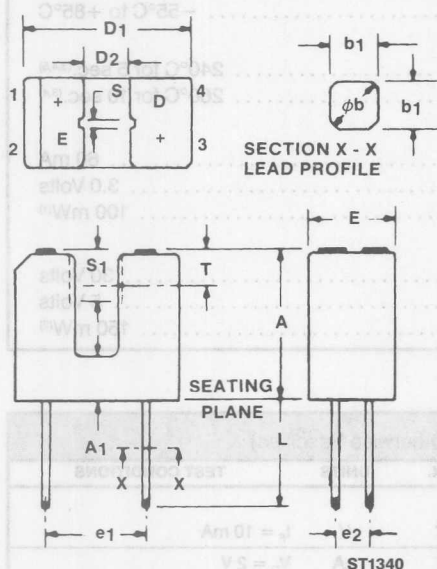


Fig. 6. Output Current vs. Distance



PACKAGE DIMENSIONS

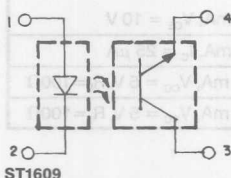


SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	10.7	11.0	.422	.433	
A ₁	3.0	3.2	.119	.125	
phi b	.600	.750	.024	.030	2
b ₁	.50 NOM.		.020 NOM.		2
D ₁	11.6	12.0	.457	.472	
D ₂	3.0	3.3	.119	.129	
e ₁	6.9	7.5	.272	.295	
e ₂	2.3	2.8	.091	.110	
E	6.15	6.35	.243	.249	
L	8.00		.315		
S	.85	1.0	.034	.039	
S ₁	3.45	3.75	.136	.147	
T	2.6 NOM.		.103 NOM.		3

NOTES:

1. INCH DIMENSIONS ARE DERIVED FROM MILLIMETERS.
2. FOUR LEADS. LEAD CROSS SECTION IS CONTROLLED BETWEEN 1.27mm (.050") FROM SEATING PLANE AND THE END OF THE LEADS.
3. THE SENSING AREA IS DEFINED BY THE "S" DIMENSION AND BY DIMENSION "T" $\pm 0.75\text{mm}$ ($\pm .030$ INCH).

PACKAGE OUTLINE



DESCRIPTION

The CNY36 is a gallium arsenide infrared emitting diode coupled with a silicon phototransistor in a plastic housing. The gap in the housing provides a means of interrupting the signal with tape, cards, shaft encoders, or other opaque material, switching the output from an "ON" to an "OFF" state.

FEATURES

- Opaque housing
- Low cost
- .035" apertures
- European "Pro Electron" registered

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Storage Temperature	-55°C to $+85^\circ\text{C}$
Operating Temperature	-55°C to $+85^\circ\text{C}$
Soldering:	
Lead Temperature (Iron)	240°C for 5 sec. ^(3,4,5)
Lead Temperature (Flow)	260°C for 10 sec. ^(3,4)

INPUT DIODE

Continuous Forward Current	60 mA
Reverse Voltage	3.0 Volts
Power Dissipation	100 mW ⁽¹⁾

OUTPUT TRANSISTOR

Collector-Emitter Voltage	30 Volts
Emitter-Collector Voltage	5 Volts
Power Dissipation	150 mW ⁽²⁾

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
Forward Voltage	V_F	—		1.7	V	$I_F = 10 \text{ mA}$
Reverse Leakage Current	I_R	—		10	μA	$V_R = 2 \text{ V}$
OUTPUT TRANSISTOR						
Emitter-Collector Breakdown	BV_{ECO}	5.0		—	V	$I_E = 100 \mu\text{A}$, $E_e = 0$
Collector-Emitter Breakdown	BV_{CEO}	30		—	V	$I_C = 10 \text{ mA}$, $E_e = 0$
Collector-Emitter Leakage	I_{CEO}	—		100	nA	$V_{CE} = 10 \text{ V}$, $E_e = 0$
COUPLED						
On-State Collector Current	$I_{C(ON)}$	0.20		—	mA	$I_F = 20 \text{ mA}$, $V_{CE} = 10 \text{ V}$
Saturation Voltage	$V_{CE(SAT)}$	—		0.40	V	$I_F = 20 \text{ mA}$, $I_C = 25 \mu\text{A}$
Turn-On Time	t_{on}		5		μS	$I_F = 30 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$
Turn-Off Time	t_{off}		5		μS	$I_F = 30 \text{ mA}$, $V_{CC} = 5 \text{ V}$, $R_L = 100\Omega$

NOTES

1. Derate power dissipation linearly 1.67 mW/ $^\circ\text{C}$ above 25°C .
2. Derate power dissipation linearly 2.50 mW/ $^\circ\text{C}$ above 25°C .
3. RMA flux is recommended.
4. Methanol or Isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip $\frac{1}{16}$ " (1.6 mm) from housing.

TYPICAL CHARACTERISTICS

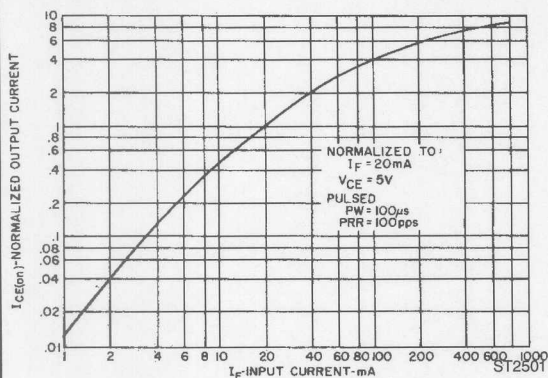


Fig. 1. Output Current vs. Input Current

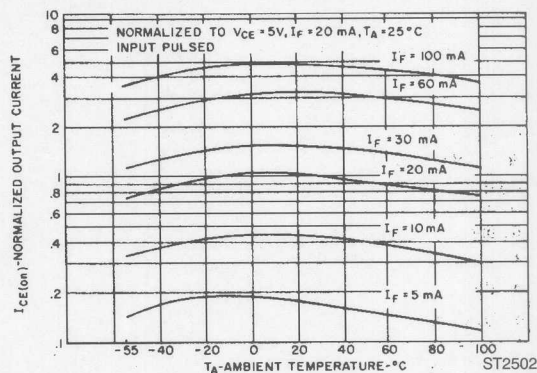


Fig. 2. Output Current vs. Temperature

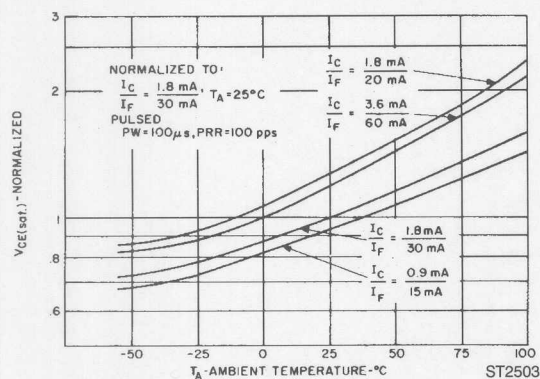


Fig. 3. $V_{CE(SAT)}$ vs. Temperature

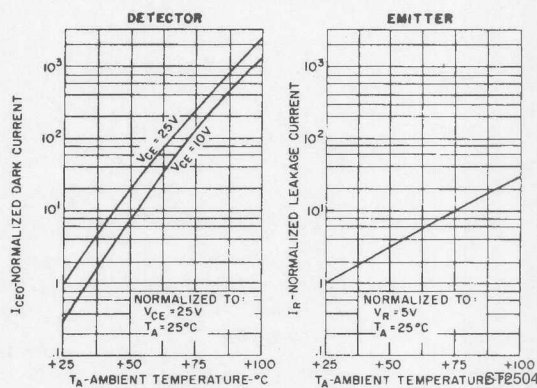


Fig. 4. Leakage Current vs. Temperature

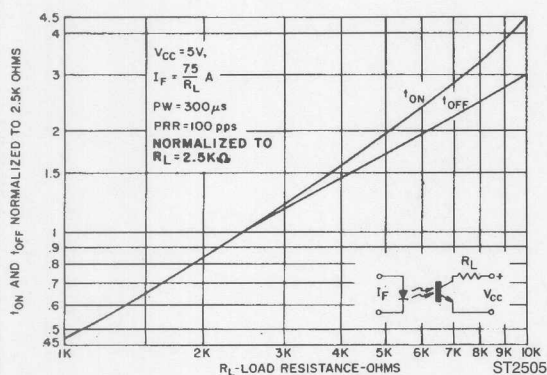


Fig. 5. Switching Speed vs. R_L

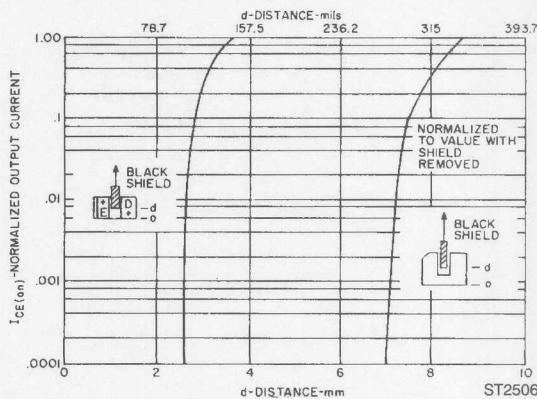
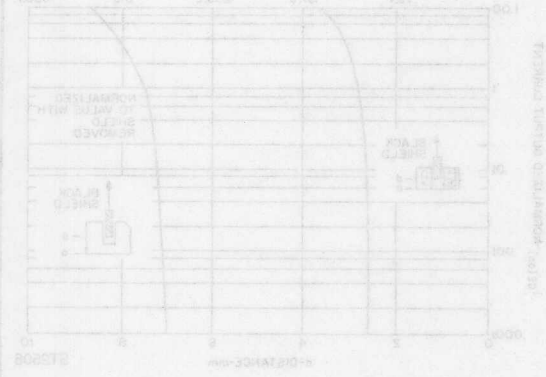
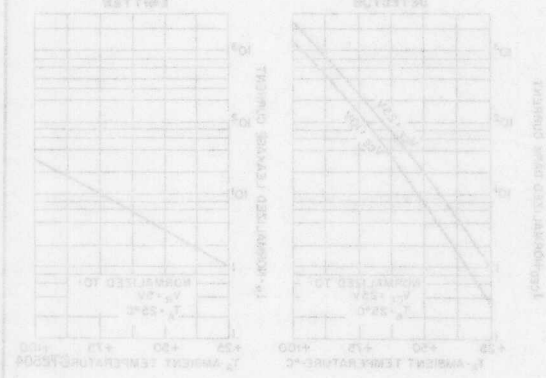
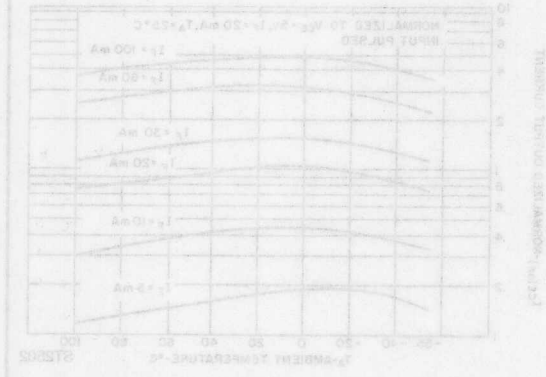
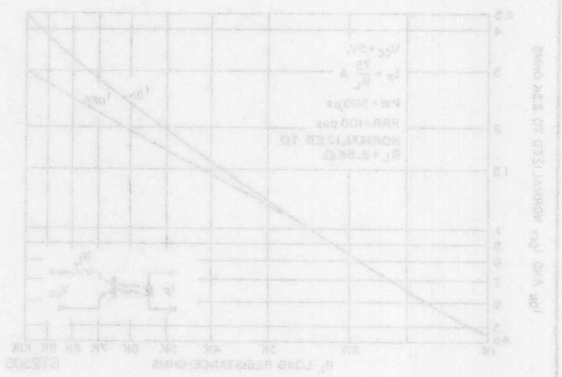
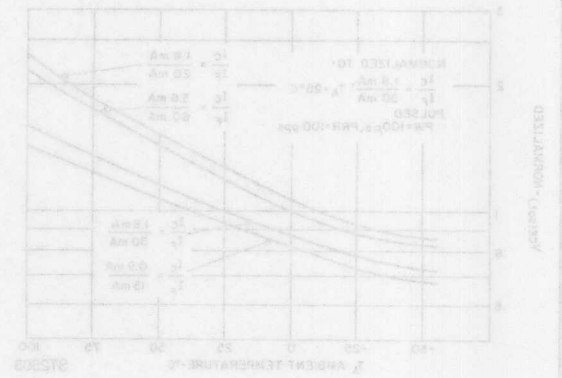
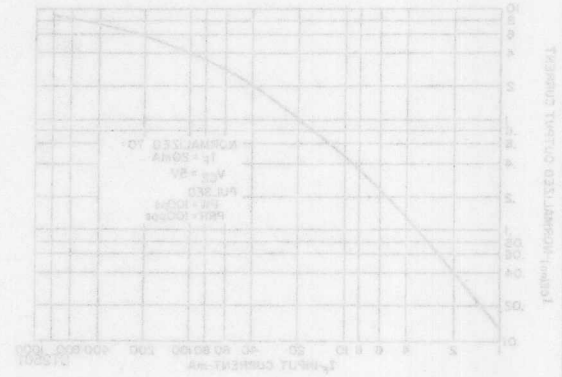


Fig. 6. Output Current vs. Distance

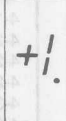
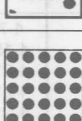
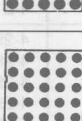


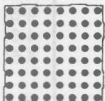
DISPLAYS

Alphanumeric Product Listing

4

Product	Page	Product	Page	Product	Page
5082-7650	4-61	GMA 8675C	4-119	MAN3630A	4-21
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5082-7653	4-61	GMA 8975C	4-119	MAN3680A	4-29
5082-7656	4-61	GMC 2475C	4-127	MAN3810A	4-21
5082-7750	4-61	GMC 2485C	4-135	MAN3820A	4-21
5082-7751	4-61	GMC 2488C	4-143	MAN3840A	4-21
5082-7756	4-61	GMC 2688C	4-143	MAN3880A	4-29
5082-7760	4-61	GMC 2875C	4-127	MAN3910A	4-37
FND310C	4-41	GMC 2885C	4-135	MAN3920A	4-37
FND317C	4-41	GMC 2888C	4-143	MAN3940A	4-37
FND318C	4-41	GMC 2975C	4-127	MAN3980A	4-29
FND350C	4-45	GMC 2985C	4-135	MAN3980A	4-37
FND357C	4-45	GMC 2988C	4-143	MAN4410A	4-49
FND358C	4-45	GMC 7175C	4-107	MAN4440A	4-49
FND360C	4-45	GMC 7175CA	4-113	MAN4610A	4-49
FND367C	4-45	GMC 7475C	4-107	MAN4630A	4-49
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GMA 2475C	4-127	GMC 7975C	4-107	MAN4705A	4-49
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GMA 2685C	4-135	GMC 8875C	4-119	MAN4940A	4-57
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GMA 2988C	4-143	MAN3220A	4-15	MAN5760	4-67
GMA 7175C	4-107	MAN3240A	4-15	MAN5950	4-67
GMA 7175CA	4-113	MAN3410A	4-21	MAN5960	4-67
GMA 7475C	4-107	MAN3420A	4-21	MAN6060	4-7
GMA 7475CA	4-113	MAN3440A	4-21	MAN6080	4-7
GMA 7975C	4-107	MAN3480A	4-29	MAN6260	4-15
GMA 7975CA	4-113	MAN3610A	4-21	MAN6280	4-15
GMA 8475C	4-119	MAN3620A	4-21	MAN6410	4-75

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	5082-7650	High Efficiency Red Red	.43-Inch; Common Anode; LHDP	840 μ cd @ 5 mA	4-61
	5082-7750			980 μ cd @ 20 mA	4-61
	5082-7651	High Efficiency Red	.43-Inch; Common Anode; RHDP	840 μ cd @ 5 mA	4-61
	5082-7653	High Efficiency Red	.43-Inch; Common Cathode; RHDP	840 μ cd @ 5 mA	4-61
	5082-7751	Red	.43-Inch; Common Anode; RHDP	980 μ cd @ 20 mA	4-61
	5082-7760	Red	.43-Inch; Common Cathode; RHDP	980 μ cd @ 20 mA	4-61
	5082-7656	High Efficiency Red Red	.43-Inch; Universal Overflow ± 1 ; RHDP	840 μ cd @ 5 mA	4-61
	5082-7756			980 μ cd @ 20 mA	4-61
	FND318C	High Efficiency Red	.362-Inch; Common Cathode ± 1 ; RHDP	450 μ cd @ 20 mA	4-41
	FND358C	Red		450 μ cd @ 20 mA	4-45
	FND368C	High Bright Red		450 μ cd @ 20 mA	4-45
	FND310C	High Efficiency Red	.362-Inch; Common Anode; RHDP	2700 μ cd @ 20 mA	4-41
	FND350C	Red		450 μ cd @ 20 mA	4-45
	FND360C	High Bright Red		450 μ cd @ 20 mA	4-45
	FND317C	High Efficiency Red		2700 μ cd @ 20 mA	4-41
	FND357C	Red	.362-Inch; Common Cathode; RHDP	450 μ cd @ 20 mA	4-45
	FND367C	High Efficiency Red		450 μ cd @ 20 mA	4-45
	GMX7175CA	High Efficiency Red		3000 μ cd @ 20 mA	4-112
	GMX7475CA	Yellow		@ 48 mA Peak	4-113
	GMX7975CA	Green	Common Anode and Common Cathode	1/8 Duty Cycle	
	GMX7175C	High Efficiency Red	0.7-Inch; 5 x 7 Array Common Anode and Common Cathode	3000 μ cd @ 20 mA	4-107
	GMX7475C	Yellow		@ 48 mA Peak	4-107
	GMX7975C	Green		1/8 Duty Cycle	4-107
	GMX8475C	Yellow	1.2-Inch; 5 x 7 Array Common Anode and Common Cathode	3000 μ cd @ 20 mA	4-119
	GMX8875C	High Efficiency Red		@ 48 mA Peak	4-119
	GMX8975C	Green		1/8 Duty Cycle	4-119
	GMX8675C	Red/Green		1/8 Duty Cycle	4-119
	GMX2475C	High Efficiency Green	2.0-Inch; 5 x 7 Array Common Anode and Common Cathode	400 μ cd	4-127
	GMX2675C	Bicolor Red/Green		@ 48 mA Peak	4-127
	GMX2875C	Yellow		1/8 Duty Cycle	4-127
	GMX2975C	High Efficiency Red		1/8 Duty Cycle	4-127

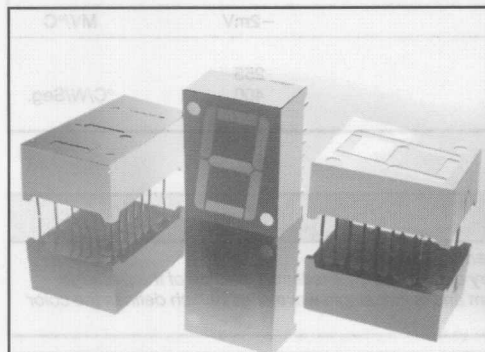
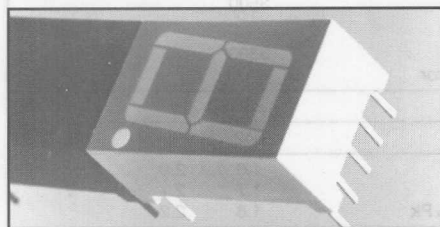
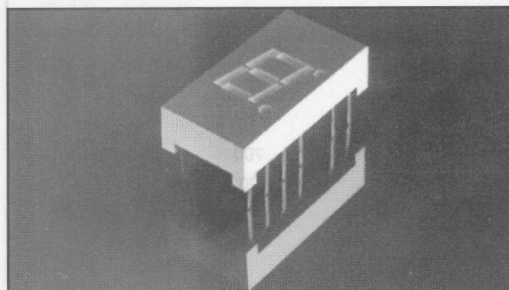
PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	GMX2485C	High Efficiency Green	2.3-Inch; 5 x 8 Array	400 μ cd	4-135
	GMA2685C	Bicolor Red/Green	Common Anode and	@ 48 mA Peak	4-135
	GMX2885C	Yellow	Common Cathode	1/8 Duty Cycle	4-135
	GMX2985C	High Efficiency Red			4-135
	GMX2488C	Green	2.3-Inch; 8 x 8 Array	3000 μ cd @ 20 mA	4-143
	GMC2688C	Red/Green	Common Anode and	@ 48 mA Peak	4-143
	GMX2888C	Yellow	Common Cathode	1/8 Duty Cycle	4-143
	GMX2988C	High Efficiency Red			4-143
	MAN3010A	AlGaAs Red	.3-Inch; Common Anode; RHDP	3600 μ cd @ 5 mA	4-7
	MAN3210A	AlGaAs Red		12000 μ cd @ 20 mA	4-15
	MAN3410A	High Efficiency Green		3200 μ cd @ 10 mA	4-21
	MAN3610A	Orange		1800 μ cd @ 10 mA	4-21
	MAN3810A	Yellow		1700 μ cd @ 10 mA	4-21
	MAN3910A	High Efficiency Red		1900 μ cd @ 10 mA	4-37
	MAN71A	Red		350 μ cd @ 10 mA	4-21
	MAN3020A	AlGaAs Red	.3-Inch; Common Anode; LHDP	3600 μ cd @ 5 mA	4-7
	MAN3220A	AlGaAs Red		12000 μ cd @ 20 mA	4-15
	MAN3420A	High Efficiency Green		3200 μ cd @ 10 mA	4-21
	MAN3620A	Orange		1800 μ cd @ 10 mA	4-21
	MAN3820A	Yellow		1700 μ cd @ 10 mA	4-21
	MAN3920A	High Efficiency Red		1900 μ cd @ 10 mA	4-37
	MAN72A	Red		350 μ cd @ 10 mA	4-21
	MAN3630A	Orange	.3-Inch; Common Anode; Polarity and Overflow	1800 μ cd @ 10 mA	4-21
	MAN73A	Red		350 μ cd @ 10 mA	4-21
	MAN3040A	AlGaAs Red	.3-Inch; Common Cathode; RHDP	3600 μ cd @ 5 mA	4-7
	MAN3240A	AlGaAs Red		12000 μ cd @ 20 mA	4-15
	MAN3440A	High Efficiency Green		3200 μ cd @ 10 mA	4-21
	MAN3640A	Orange		1800 μ cd @ 10 mA	4-21
	MAN3840A	Yellow		1700 μ cd @ 10 mA	4-21
	MAN3940A	High Efficiency Red	.3-Inch; Common Cathode; RHDP; 10-Pin	1900 μ cd @ 10 mA	4-37
	MAN74A	Red		350 μ cd @ 10 mA	4-21
	MAN3480A	High Efficiency Green		3200 μ cd @ 10 mA	4-29
	MAN3680A	Orange		1800 μ cd @ 10 mA	4-29
	MAN3880A	Yellow		1700 μ cd @ 10 mA	4-29
	MAN3980A	High Efficiency Red		1900 μ cd @ 10 mA	4-29
	MAN78A	Red		350 μ cd @ 10 mA	4-29
	MAN4705A	Red	.4-Inch; Universal (CA/CC) Overflow $\pm$ 1; RHDP	350 μ cd @ 10 mA	4-49
	MAN4630A	Orange		1800 μ cd @ 10 mA	4-49

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	MAN4410A	High Efficiency Green	.4-Inch; Common Anode; RHDP	3200 μ cd @ 10 mA	4-49
	MAN4610A	Orange		1800 μ cd @ 10 mA	4-49
	MAN4710A	Red		350 μ cd @ 10 mA	4-49
	MAN4910A	High Efficiency Red		1900 μ cd @ 10 mA	4-57
	MAN4440A	High Efficiency Green	.4-Inch; Common Cathode; RHDP	3200 μ cd @ 10 mA	4-49
	MAN4640A	Orange		1800 μ cd @ 10 mA	4-49
	MAN4740A	Red		350 μ cd @ 10 mA	4-49
	MAN4940A	High Efficiency Red		1900 μ cd @ 10 mA	4-57
	MAN5350	Yellow	.51-Inch; Common Anode; RHDP	1200 μ cd @ 20 mA	4-67
	MAN5960		.51-Inch; Common Cathode; RHDP		4-67
	MAN5450	Green	.51-Inch; Common Anode; RHDP	3000 μ cd @ 20 mA	4-67
	MAN5460		.51-Inch; Common Cathode; RHDP		4-67
	MAN5750	Red	.51-Inch; Common Anode; RHDP	500 μ cd @ 20 mA	4-67
	MAN5760		.51-Inch; Common Cathode; RHDP		4-67
	MAN5950	Orange Red	.51-Inch; Common Anode; RHDP	2500 μ cd @ 20 mA	4-67
	MAN5360		.51-Inch; Common Cathode; RHDP		4-67
	MAN6410	High Efficiency Green	0.56-Inch; Common Anode; RHDP; 2-Digit	3300 μ cd @ 10 mA	4-75
	MAN6440		0.56-Inch; Common Cathode; RHDP; 2-Digit		4-75
	MAN6610	Orange	0.56-Inch; Common Anode; RHDP; 2-Digit	2200 μ cd @ 10 mA	4-79
	MAN6640		0.56-Inch; Common Cathode; RHDP; 2-Digit		4-79
	MAN6710	Red	0.56-Inch; Common Anode; RHDP; 2-Digit	420 μ cd @ 10 mA	4-85
	MAN6740		0.56-Inch; Common Cathode; RHDP; 2-Digit		4-85
	MAN6910	High Efficiency Red	0.56-Inch; Common Anode; RHDP; 2-Digit	2200 μ cd @ 10 mA	4-89
	MAN6940		0.56-Inch; Common Cathode; RHDP; 2-Digit		4-89
	MAN6630	Orange	0.56-Inch; Common Anode; RHDP; 1½-Digit	2200 μ cd @ 10 mA	4-79
	MAN6650		0.56-Inch; Common Cathode; RHDP; 1½-Digit		4-79
	MAN6730	Red	0.56-Inch; Common Anode; RHDP; 1½-Digit	420 μ cd @ 10 mA	4-85
	MAN6750		0.56-Inch; Common Cathode; RHDP; 1½-Digit		4-85
	MAN6930	High Efficiency Red	0.56-Inch; Common Anode; Overflow $\pm$ 1.8, RHDP	2200 μ cd @ 10 mA	4-89
	MAN6950		0.56-Inch; Common Cathode; Overflow $\pm$ 1.8, RHDP		4-89
	MAN6060	AlGaAs Red Low Current	0.56-Inch; Common Anode; RHDP	4200 μ cd @ 5 mA	4-7
	MAN6080		0.56-Inch; Common Cathode; RHDP		4-7
	MAN6260	AlGaAs Red Hi. Intensity	0.56-Inch; Common Anode; RHDP	15000 μ cd @ 20 mA	4-15
	MAN6280		0.56-Inch; Common Cathode; RHDP		4-15
	MAN6460	High Efficiency Green	0.56-Inch; Common Anode; RHDP	3300 μ cd @ 10 mA	4-75
	MAN6480		0.56-Inch; Common Cathode; RHDP		4-75
	MAN6660	Orange	0.56-Inch; Common Anode; RHDP	2200 μ cd @ 10 mA	4-79
	MAN6680		0.56-Inch; Common Cathode; RHDP		4-79

PACKAGE	PART NUMBER	COLOR	DESCRIPTION	BRIGHTNESS OR LUMINOUS INTENSITY (TYPICAL)	PAGE
	MAN6760	Red	0.56-Inch; Common Anode; RHDP;	420 μ cd @ 10 mA	4-85
	MAN6780		0.56-Inch; Common Cathode; RHDP		4-85
	MAN6960	High Efficiency Red	0.56-Inch; Common Anode; RHDP;	2200 μ cd @ 10 mA	4-89
	MAN6980		0.56-Inch; Common Cathode; RHDP		4-89
	MAN6675	Orange	0.56-Inch; Common Anode; RHDP; ± 1 Overflow	2200 μ cd @ 10 mA	4-79
	MAN6695		0.56-Inch; Common Cathode; RHDP; ± 1 Overflow		4-79
	MAN8010	AlGaAs Red	.800-Inch; Common Anode; RHDP	3500 μ cd @ 5 mA	4-7
	MAN8040		.800-Inch; Common Cathode; RHDP		4-7
	MAN8210	AlGaAs Red	.800-Inch; Common Anode; RHDP	11000 μ cd @ 20 mA	4-15
	MAN8240		.800-Inch; Common Cathode; RHDP		4-15
	MAN8410	High Efficiency Green	.800-Inch; Common Anode; RHDP;	3200 μ cd @ 10 mA	4-95
	MAN8440		.800-Inch; Common Cathode; RHDP		4-95
	MAN8610	Orange	.800-Inch; Common Anode; RHDP;	2200 μ cd @ 10 mA	4-99
	MAN8640		.800-Inch; Common Cathode; RHDP		4-99
	MAN8910	High Efficiency Red	.800-Inch; Common Anode; RHDP;	2200 μ cd @ 10 mA	4-103
	MAN8940		.800-Inch; Common Cathode; RHDP		4-103

**DOUBLE HETEROJUNCTION
AlGaAs RED
LOW CURRENT DISPLAYS**

7.6mm (0.3in) MAN30X0A
14.2mm (0.56in) MAN60X0
20.0mm (0.8in) MAN80X0



DESCRIPTION

This line of solid state LED displays uses newly developed Double Heterojunction (HD) AlGaAs/GaAs material to emit deep red light at 650 nm. This material has outstanding efficiency at low drive currents and can be either DC or pulse driven. Viewability at up to 10 meters (MAN8000 Series) is available for applications such as instruments weighing scales, meters and point-of-sale terminals.

FEATURES

- Low Power Consumption
Typical power consumption is 1.6mA/seg. at 1mA drive ideal for battery operated applications
- Typical intensity of 650 μ cd/seg at 1mA drive
- Excellent for multiplexing long digit strings
- Compatible with monolithic LED display drivers
- Three Character Sizes
7.6mm (0.3in), 14.2mm (0.56in), 20.0mm (0.8in)
- Common anode or common cathode
- Excellent character appearance
Wide viewing angle
Grey body for optimum contrast
- Categorized for luminous intensity. Use of like categorizes yields a uniform display

MODEL NUMBERS

PART NO.	CHARACTER SIZE	DESCRIPTION	PACKAGE DRAWING
MAN3010A	0.3" (7.6mm)	Common anode; right hand decimal	A
MAN3040A		Common cathode; right hand decimal	B
MAN3020A		Common anode; left hand decimal	C
MAN6060	0.56" (14.2mm)	Common anode; right hand decimal	D
MAN6080		Common cathode; right hand decimal	E
MAN8010	0.8" (20mm)	Common anode; right hand decimal	F
MAN8040		Common cathode; right hand decimal	G

ELECTRICAL/OPTICAL CHARACTERISTICS AT T _A = 25°C							
DESCRIPTION	SYMBOL	DEVICE	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Luminous intensity/segment [1,2] (digit average)	I _v	MAN3000A Series	1 mA DC	315	600		μcd
			5 mA DC		3600		
			20 mA Pk: 1 of 4 Duty Factor		3300		
		MAN6000 Series	1 mA DC	400	700		μcd
			5 mA DC		4200		
			20 mA Pk: 1 of 4 Duty Factor		3900		
		MAN8000 Series	1 mA DC	270	500		μcd
			5 mA DC		3500		
			20 mA Pk: 1 of 4 Duty Factor		3300		
Peak wavelength	λ _{Peak}	All Devices			650		nm
Dominant wavelength [3]	λ _d	All Devices			642		nm
Forward voltage/segment or DP	V _F	All Devices	I _F = 1 mA I _F = 5 mA I _F = 20 mA Pk		1.6 1.7 1.8	2.0 2.1 2.2	V
Reverse voltage/segment or DP	V _R	All Devices	I _R = 100 μA	3.0	15		V
Temp. coefficient of V _F /seg. or DP	ΔV _F /°C				-2mV		MV/°C
Thermal resistance LED junction— to—pin	RθJ-PIN	MAN3000 MAN6000 MAN8000			255 400 430		°C/W/Seg.

NOTES

1. Case temperature of the device immediately prior to the intensity measurement is 25°C.
2. The digits are categorized for luminous intensity with the intensity category designated by a letter on the side of the package.
3. The dominant wavelength, λ_d, is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.

MAN30X0A MAN60X0 MAN80X0

PART NO.	CHARACTER SIZE	DESCRIPTION	PACKAGE DRAWING
MAN3010A		Common anode; right hand decimal	A
MAN3040A		Common cathode; right hand decimal	B
MAN3020A	0.3" (7.6mm)	Common anode; left hand decimal	C
MAN6080		Common anode; right hand decimal	D
MAN6080	0.38" (9.6mm)	Common cathode; right hand decimal	E
MAN8010		Common anode; right hand decimal	F
MAN8040	0.3" (7.6mm)	Common cathode; right hand decimal	G

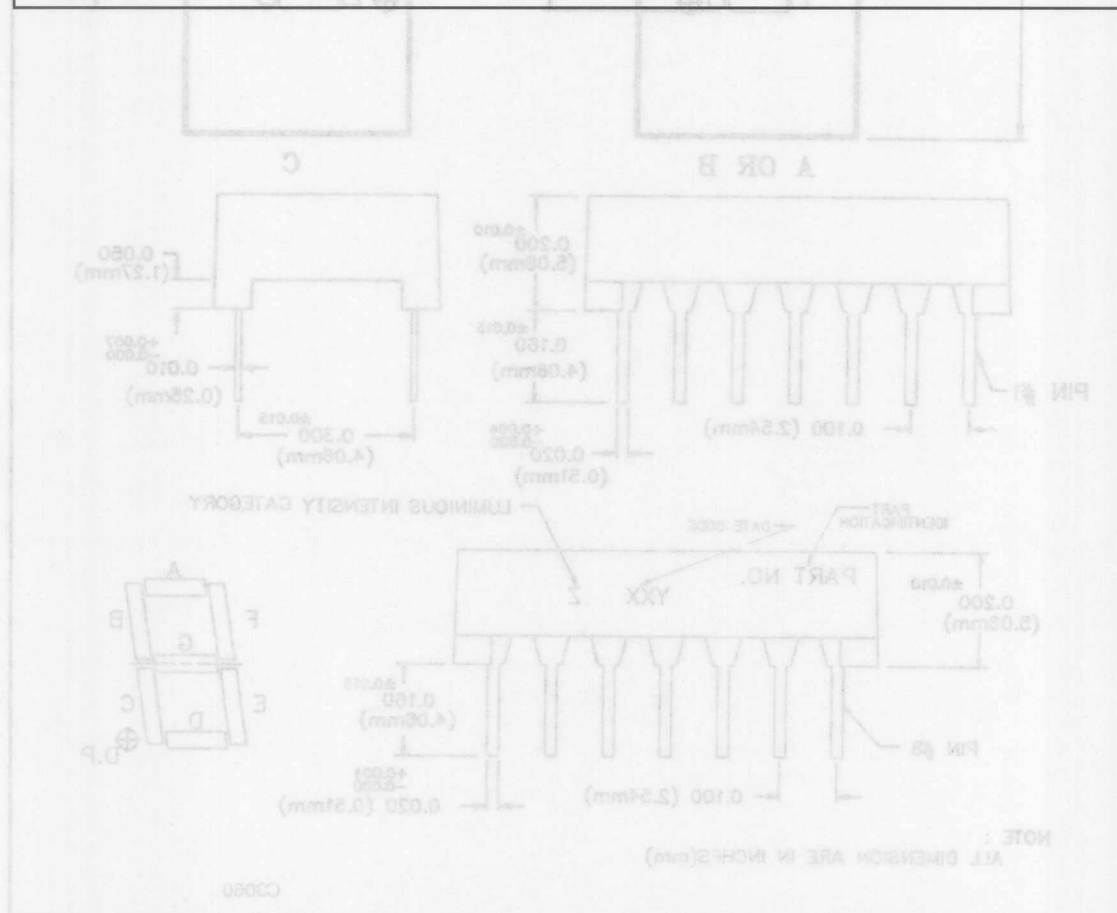
ABSOLUTE MAXIMUM RATINGS (All Products)

Average power per segment or DP ($T_A=25^\circ\text{C}$)	37 mW
Peak forward current per segment or DP ($T_A=25^\circ\text{C}$)[1]	45 mA
Average or DC forward current per segment or DP ($T_A=25^\circ\text{C}$)	15 mA
Operating temperature range	-20°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+85^\circ\text{C}$
Reverse voltage per segment or DP	3.0 V
Lead solder temperature (1.59 mm [1/16"] below seating plane)	260°C for 3 sec.

NOTES: 1. Do not exceed maximum average current per segment.

NOTES

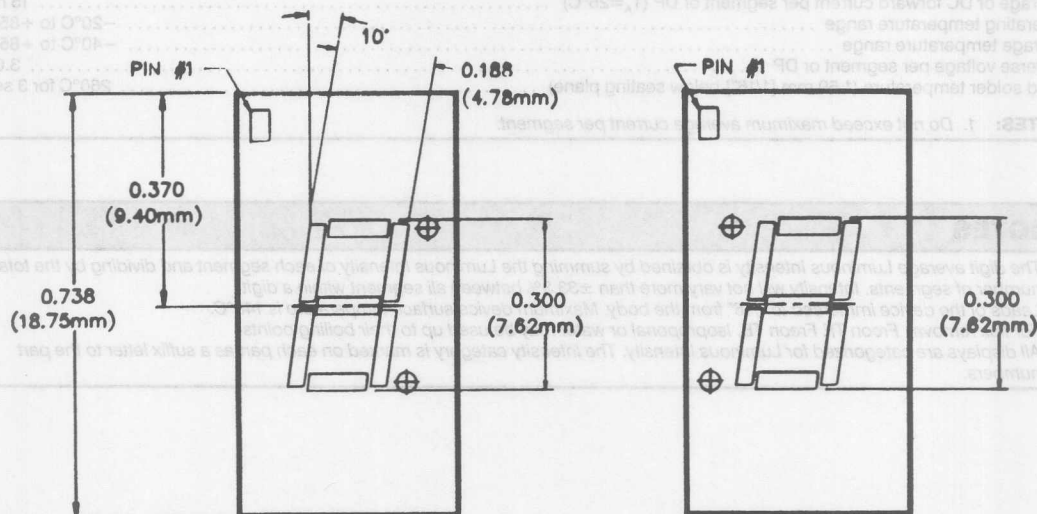
1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segment within a digit.
2. Leads of the device immersed to 1/16" from the body. Maximum device surface temperature is 140°C .
3. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
4. All displays are categorized for Luminous Intensity. The intensity category is marked on each part as a suffix letter to the part numbers.



PACKAGE DIMENSIONS

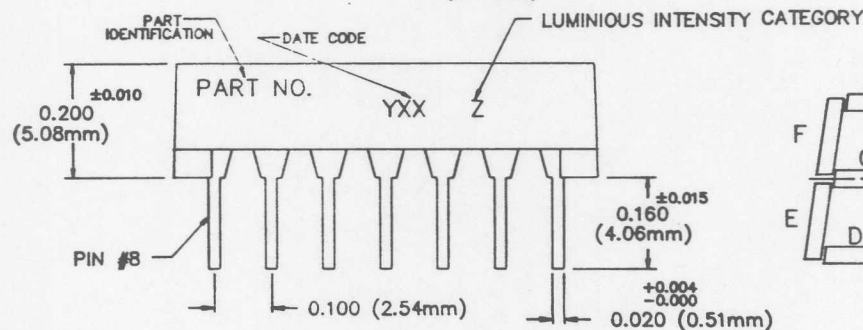
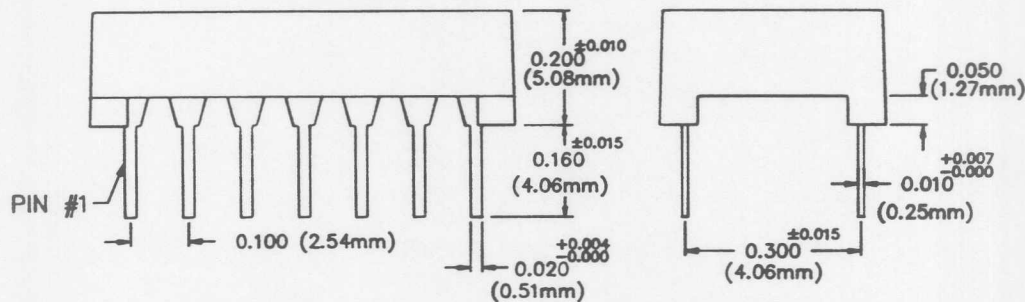
MAN3000A SERIES

Notes:
1. Do not exceed maximum average current per segment.
2. The digit seven is not used in this series.
3. All displays are tested for luminous intensity. The intensity category is marked on each part by a suffix letter to the part number.
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A OR B

C



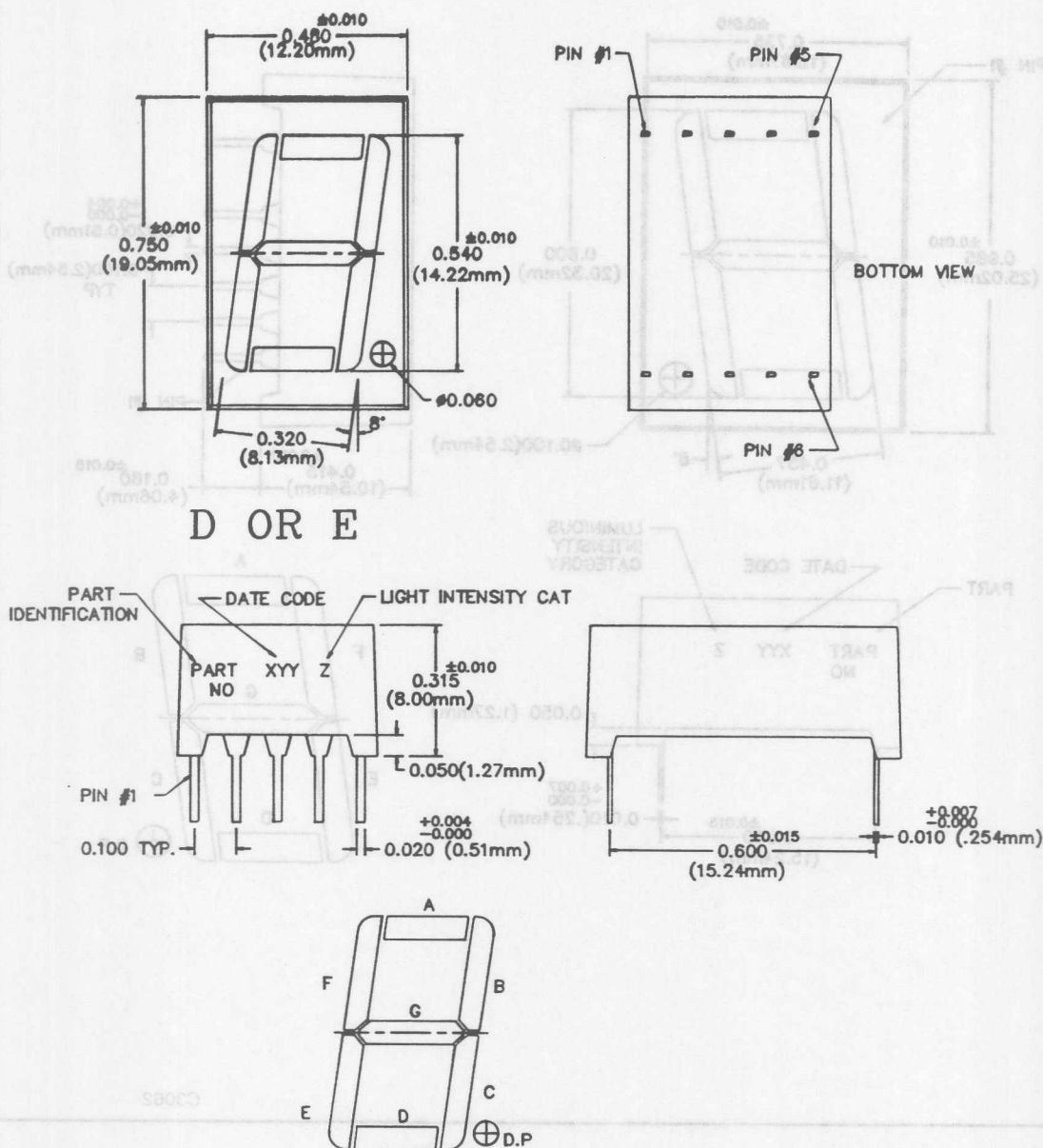
NOTE :
ALL DIMENSION ARE IN INCHES(mm)

C3060

MAN30X0A MAN60X0 MAN80X0

PACKAGE DIMENSIONS

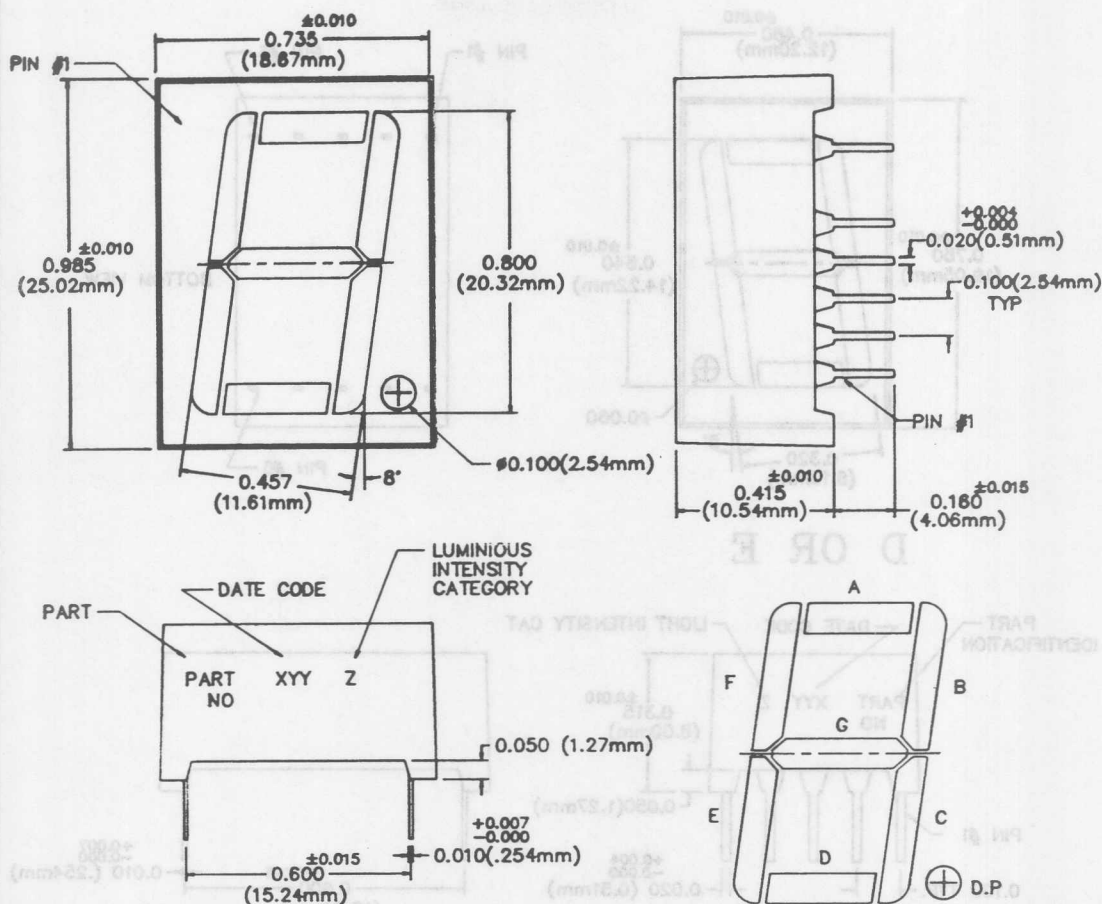
MAN6000 SERIES



C3061

PACKAGE DIMENSIONS

MAN8000 SERIES



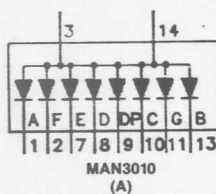
C3062

MAN30X0A MAN60X0 MAN80X0

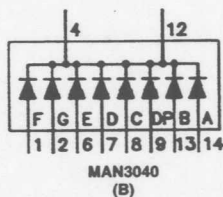
ELECTRICAL CONNECTIONS

PIN NO.	A MAN3010A	B MAN3040A	C MAN3020A	D MAN6060	E MAN6080	F MAN8010	G MAN8040
1	Cathode A	Anode F	Cathode A	Cathode E	Anode E	No Connection	No Connection
2	Cathode F	Anode G	Cathode F	Cathode D	Anode D	A Cathode	A Anode
3	Common Anode	No Pin	Common Anode	Common Anode	Common Cathode	F Cathode	F Anode
4	No Pin	Common Cathode	No Pin	Cathode C	Anode C	Common Anode	Common Cathode
5	No Pin	No Pin	No Pin	Cathode D.P	Anode D.P	E Cathode	E Anode
6	No Connection	Anode E	Cathode D.P	Cathode B	Anode B	—	—
7	Cathode E	Anode D	Cathode E	Cathode A	Anode A	E Cathode	E Anode
8	Cathode D	Anode C	Cathode D	Common Anode	Common Cathode	—	—
9	Cathode D.P	Anode D.P	No Connection	Cathode F	Anode F	D Cathode	Common Cathode
10	Cathode C	No Pin	Cathode C	Cathode G	Anode G	D.P Cathode	D.P Anode
11	Cathode G	No Pin	Cathode G	—	—	D Cathode	D Anode
12	No Pin	Common Cathode	No Pin	—	—	Common Anode	Common Cathode
13	Cathode B	Anode B	Cathode B	—	—	C Cathode	C Anode
14	Common Anode	Anode A	Common Anode	—	—	G Cathode	G Anode
15	—	—	—	—	—	B Cathode	B Anode
16	—	—	—	—	—	—	—
17	—	—	—	—	—	Common Anode	Common Cathode
18	—	—	—	—	—	—	—

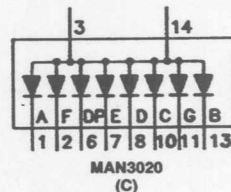
ELECTRICAL SCHEMATIC



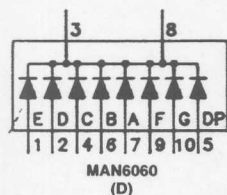
C3070



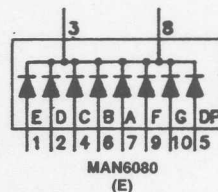
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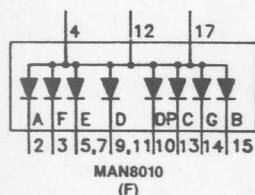
C3072



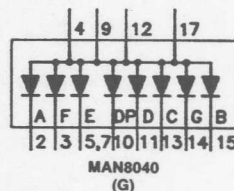
C3073



C3074



C3075



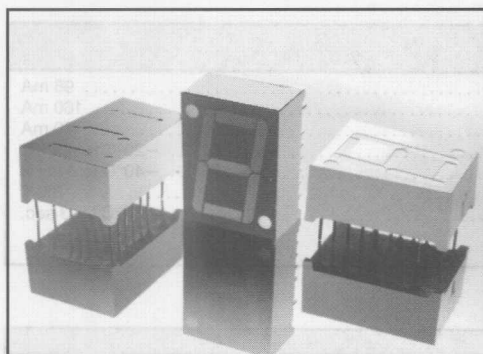
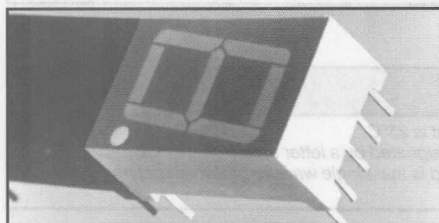
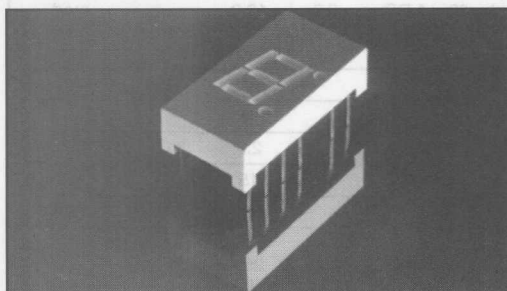
C3076

Pin No.	MAN30015A	A	B	C	D	E	F	G
1	Cathode A	Cathode A	Anode F	Cathode A	Cathode E	Anode E	No Connection	No Connection
2	Cathode F	Cathode F	Anode G	Cathode F	Cathode D	Anode D	A Cathode	A Anode
3	Common Anode	Common Anode	No Pin	Common Anode	Common Anode	Common Cathode	F Cathode	F Anode
4	No Pin	No Pin	Common Cathode	No Pin	Cathode C	Anode C	Common Anode	Common Cathode
5	No Pin	No Pin	No Pin	No Pin	Cathode D.P.	Anode D.P.	E Cathode	E Anode
6	No Connection	Anode E	Cathode D.P.	Cathode D.P.	Cathode B	Anode B	---	---
7	Cathode E	Anode D	Cathode E	Cathode E	Cathode A	Anode A	E Cathode	E Anode
8	Cathode D	Anode C	Cathode D	Cathode D	Common Anode	Common Cathode	---	---
9	Cathode D.P.	Anode D.P.	No Connection	Cathode F	Anode F	D Cathode	Common Cathode	Common Cathode
10	Cathode D	No Pin	Cathode C	Cathode C	D.P. Cathode	D.P. Cathode	D.P. Anode	D.P. Anode
11	Cathode G	No Pin	Cathode G	Cathode G	D Cathode	D Cathode	D Anode	D Anode
12	No Pin	Common Cathode	Common Cathode	No Pin	Common Anode	Common Anode	Common Cathode	Common Cathode
13	Cathode B	Anode B	Cathode B	Cathode B	G Cathode	G Cathode	G Anode	G Anode
14	Common Anode	Anode A	Common Anode	Common Anode	B Cathode	B Cathode	B Anode	B Anode
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DOUBLE HETEROJUNCTION AlGaAs RED SUNLIGHT VIEWABLE DISPLAYS

7.6mm (0.3in) **MAN32X0A**
14.2mm (0.56in) **MAN62X0**
20.0mm (0.8in) **MAN82X0**



DESCRIPTION

This line of solid state LED displays uses newly developed Double Heterojunction (DH) AlGaAs/GaAs material technology. This LED material has outstanding light output efficiency over a wide range of drive currents and can either be DC or pulse driven. The color is deep red at the dominant wavelength of 637 nanometers. Viewability of up to 10 meters (MAN8200 Series) is available for applications in bright sunlight such as automotive and avionic instrumentation, portable instruments, point-of-sale terminals and gas pumps.

FEATURES

- Sunlight Viewable
Typical intensity of 15mcd/Seg at 20mA Drive
- Capable of high drive currents
- Excellent for multiplexing long digit strings
- Three Character Sizes
7.6mm (0.3in), 14.2mm (0.56in), 20.0mm (0.8in)
- Excellent character appearance
Evenly lighted segments
Wide viewing angle
Grey body for optimum contrast
- Categorized for luminous intensity. Use of like categorizes yields a uniform display

MODEL NUMBERS

PART NO.	CHARACTER SIZE	DESCRIPTION	PACKAGE DRAWING
MAN3210A	0.3" (7.6mm)	Common anode; right hand decimal	A
MAN3240A		Common cathode; right hand decimal	B
MAN3220A		Common anode; left hand decimal	C
MAN6260	0.56" (14.2mm)	Common anode; right hand decimal	D
MAN6280		Common cathode; right hand decimal	E
MAN8210	0.8" (20mm)	Common anode; right hand decimal	F
MAN8240		Common cathode; right hand decimal	G

ELECTRICAL/OPTICAL CHARACTERISTICS AT $T_A=25^\circ\text{C}$

DESCRIPTION	SYMBOL	DEVICE	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Luminous intensity/segment [1,2] (digit average)	I_v	MAN3200A Series MAN6200 Series MAN8200 Series	$I_F=20\text{ mA DC}$ $I_F=20\text{ mA DC}$ $I_F=20\text{ mA DC}$	6.9 9.1 6.0	12.0 15.0 11.0		mc cd cd
Peak wavelength	λ_{Peak}	All Devices			645		nm
Dominant wavelength [3]	λ_d	All Devices			637		nm
Forward voltage/segment or DP	V_F	All Devices	$I_F=100\text{ mA}$		2.0	3.0	V
Reverse voltage/segment or DP	V_R	All Devices	$I_R=100\text{ }\mu\text{A}$	3.0	15		V
Temp. coefficient of V_F /seg. or DP	$\Delta V_F/^\circ\text{C}$				-2mV		mV/°C
Thermal resistance LED junction— to—pin	R θ J-PIN	MAN3200A MAN6200 MAN8200			255 400 430		°C/W/Seg.

NOTES

1. Case temperature of the device immediately prior to the intensity measurement is 25°C .
2. The digits are categorized for luminous intensity with the intensity category designated by a letter on the side of the package.
3. The dominant wavelength, λ_d , is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.

ABSOLUTE MAXIMUM RATINGS (All Products)

Average power per segment or DP ($T_A=25^\circ\text{C}$)	96 mA
Peak forward current per segment or DP ($T_A=25^\circ\text{C}$) [1]	160 mA
Average or DC forward current per segment or DP ($T_A=25^\circ\text{C}$)	40 mA
Operating temperature range	-20°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+85^\circ\text{C}$
Reverse voltage per segment or DP	3.0 V
Lead solder temperature (1.59 mm [1/16"] below seating plane)	260°C for 3 sec.

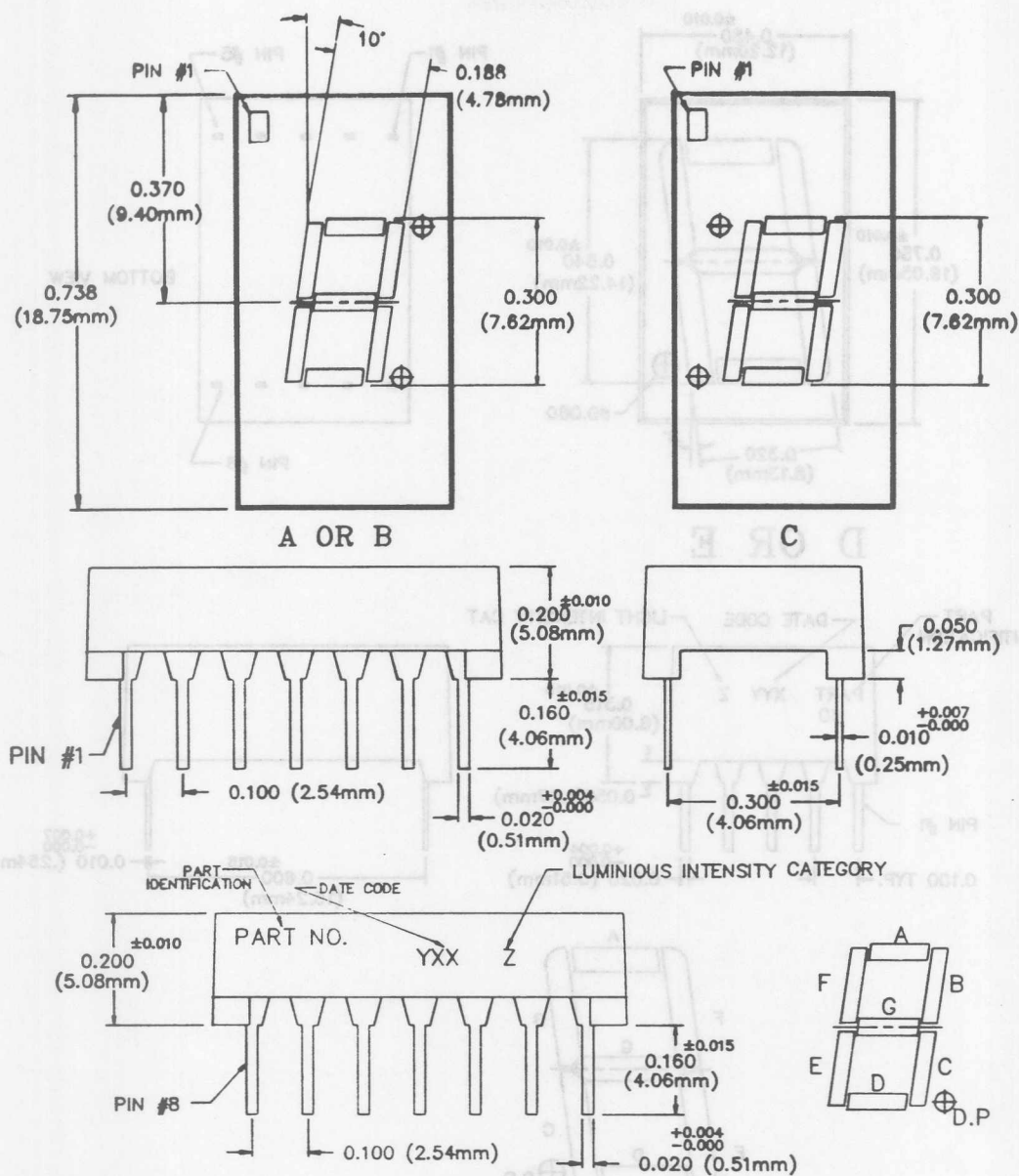
NOTES: 1. Do not exceed maximum average current per segment.

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segment within a digit.
2. Leads of the device immersed to 1/16" from the body. Maximum device surface temperature is 140°C .
3. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
4. All displays are categorized for Luminous Intensity. The intensity category is marked on each part as a suffix letter to the part numbers.

PACKAGE DIMENSIONS

MAN3200A SERIES

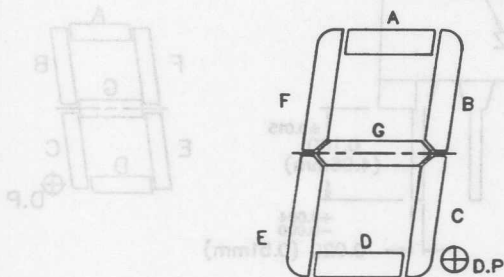
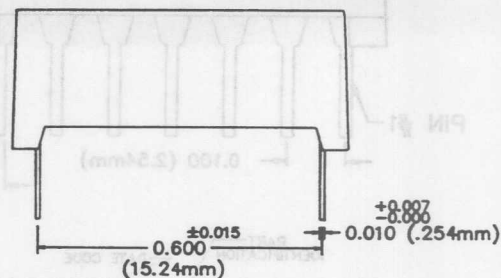
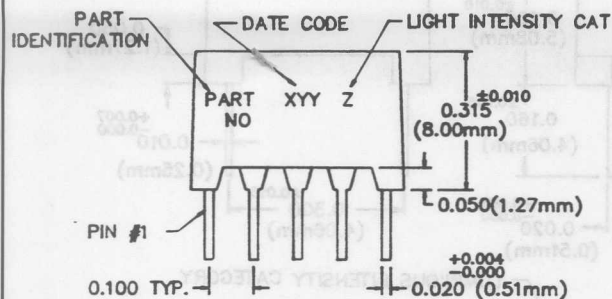
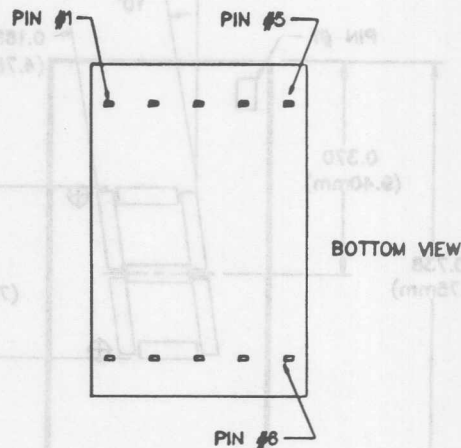
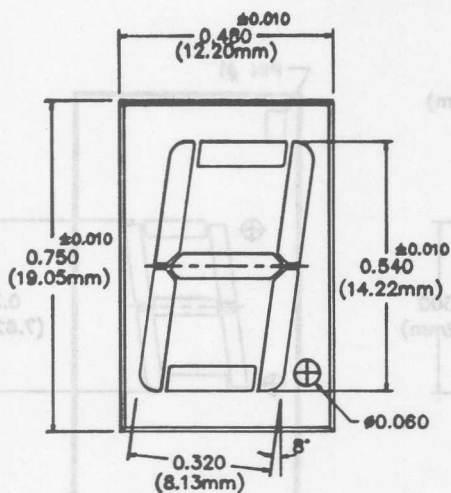


NOTE :
ALL DIMENSION ARE IN INCHES(mm)

C3060

PACKAGE DIMENSIONS

MAN6200 SERIES

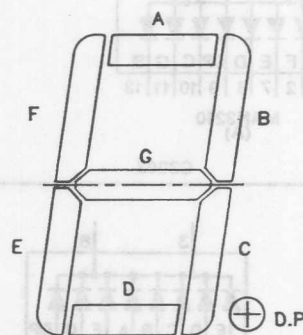
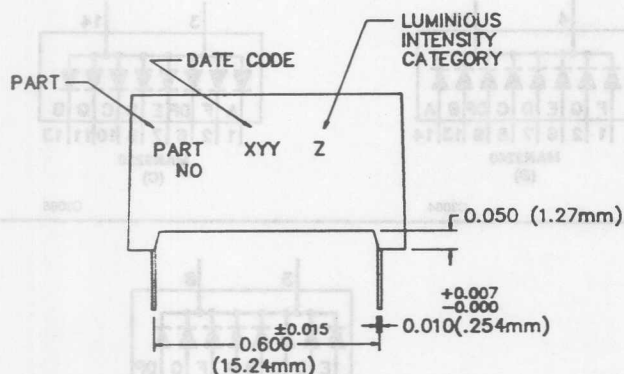
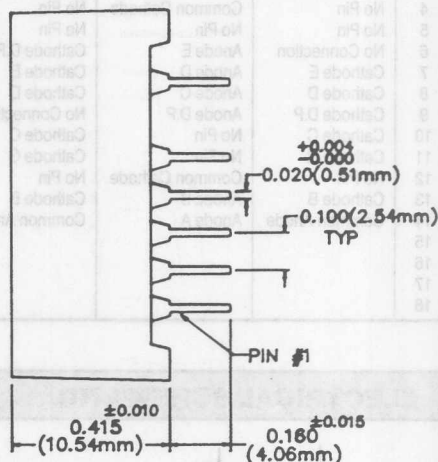
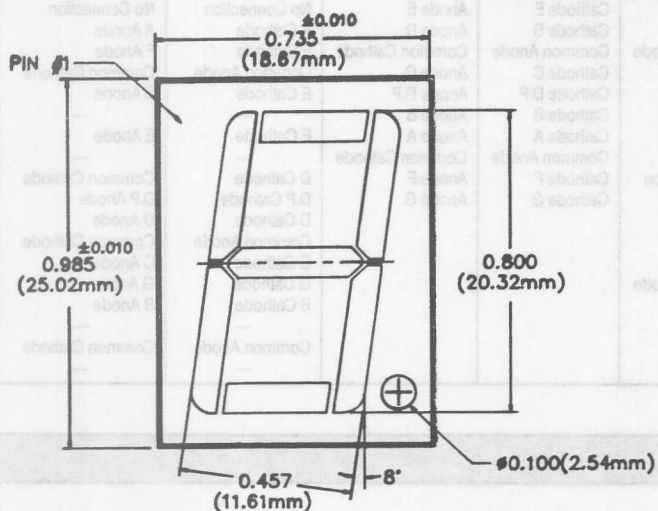


C3061

MAN32X0A MAN62X0 MAN82X0

PACKAGE DIMENSIONS

MAN8200 SERIES



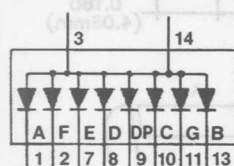
4

MAN32X0A MAN62X0 MAN82X0

ELECTRICAL CONNECTIONS

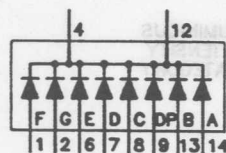
PIN NO.	A MAN3210A	B MAN3240A	C MAN3220A	D MAN6260	E MAN6280	F MAN8210	G MAN8240
1	Cathode A	Anode F	Cathode A	Cathode E	Anode E	No Connection	No Connection
2	Cathode F	Anode G	Cathode F	Cathode D	Anode D	A Cathode	A Anode
3	Common Anode	No Pin	Common Anode	Common Anode	Common Cathode	F Cathode	F Anode
4	No Pin	Common Cathode	No Pin	Cathode C	Anode C	Common Anode	Common Cathode
5	No Pin	No Pin	No Pin	Cathode D.P	Anode D.P	E Cathode	E Anode
6	No Connection	Anode E	Cathode D.P	Cathode B	Anode B	—	—
7	Cathode E	Anode D	Cathode E	Cathode A	Anode A	E Cathode	E Anode
8	Cathode D	Anode C	Cathode D	Common Anode	Common Cathode	—	—
9	Cathode D.P	Anode D.P	No Connection	Cathode F	Anode F	D Cathode	Common Cathode
10	Cathode C	No Pin	Cathode C	Cathode G	Anode G	D.P Cathode	D.P Anode
11	Cathode G	No Pin	Cathode G	—	—	D Cathode	D Anode
12	No Pin	Common Cathode	No Pin	—	—	Common Anode	Common Cathode
13	Cathode B	Anode B	Cathode B	—	—	C Cathode	C Anode
14	Common Anode	Anode A	Common Anode	—	—	G Cathode	G Anode
15	—	—	—	—	—	B Cathode	B Anode
16	—	—	—	—	—	—	—
17	—	—	—	—	—	Common Anode	Common Cathode
18	—	—	—	—	—	—	—

ELECTRICAL SCHEMATIC



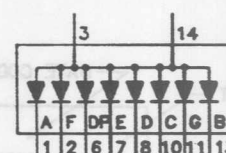
MAN3210
(A)

C3063



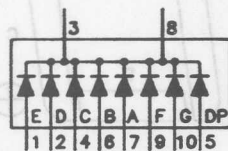
MAN3240
(B)

C3064



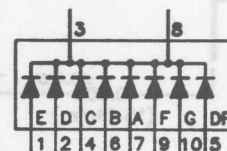
MAN3220
(C)

C3065



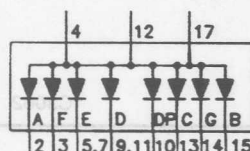
MAN6260
(D)

C3066



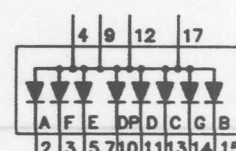
MAN6280
(E)

C3067



MAN8210
(F)

C3068

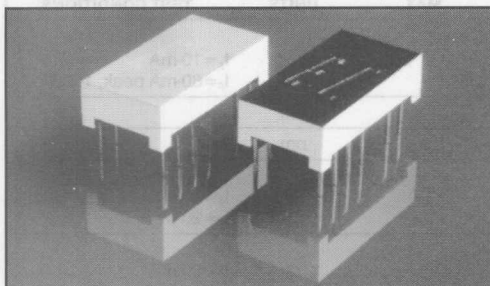


MAN8240
(G)

C3069

**HIGH EFFICIENCY GREEN MAN3400A
ORANGE MAN3600A**

**RED MAN70A
YELLOW MAN3800A**



DESCRIPTION

The MAN3400A, MAN3600A, MAN70A and MAN3800A Series provides a choice of color of LED displays. Standard units are available in Red, Green, Orange and Yellow. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Yellow and High Efficiency Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

FEATURES

- Common anode or common cathode models
- Red, Yellow, Green and Orange
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard 14 pin dual-in-line package configuration
- Wide angle viewing...150°

APPLICATIONS

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION
MAN3410A	High Efficiency Green	Common Anode; Right Hand Decimal
MAN3420A	High Efficiency Green	Common Anode; Left Hand Decimal
MAN3440A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3610A	Orange	Common Anode; Right Hand Decimal
MAN3620A	Orange	Common Anode; Left Hand Decimal
MAN3630A	Orange	Common Anode; Overflow ± 1
MAN3640A	Orange	Common Cathode; Right Hand Decimal
MAN71A	Red	Common Anode; Right Hand Decimal
MAN72A	Red	Common Anode; Left Hand Decimal
MAN73A	Red	Common Anode; Overflow ± 1
MAN74A	Red	Common Cathode; Right Hand Decimal
MAN3810A	Yellow	Common Anode; Right Hand Decimal
MAN3820A	Yellow	Common Anode; Left Hand Decimal
MAN3840A	Yellow	Common Cathode; Right Hand Decimal

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN3410A, 3420A, 3440A					
Luminous Intensity, digit average (See Notes 1 and 3)	750 900	3200 4000		μ cd μ cd	$I_F = 10$ mA $I_F = 60$ mA peak, 1:6 DF
Peak emission wavelength		562		nm	
Spectral line half width		30		nm	
Forward voltage					
Segment		2.2	3.0	V	$I_F = 20$ mA
Decimal point		2.2	3.0	V	$I_F = 20$ mA
Dynamic resistance					
Segment		12		Ω	$I_F = 20$ mA
Decimal point		12		Ω	$I_F = 20$ mA
Capacitance					
Segment		40		pF	V=0
Decimal point		40		pF	V=0
Reverse current					
Segment			100	μ A	$V_R = 5.0$ V
Decimal point			100	μ A	$V_R = 5.0$ V
MAN3610A, 3620A, 3630A, 3640A					
Luminous Intensity, digit average (See Note 1 and 3)	510	1800		μ cd	$I_F = 10$ mA
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	V=0
Decimal point		35		pF	V=0
Reverse current					
Segment			100	μ A	$V_R = 5.0$ V
Decimal point			100	μ A	$V_R = 5.0$ V

PART NUMBER	COLOR	DESCRIPTION
MAN3410A	High Efficiency Green	Common Anode; Right Hand Decimal
MAN3420A	High Efficiency Green	Common Anode; Left Hand Decimal
MAN3430A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3440A	High Efficiency Green	Common Cathode; Left Hand Decimal
MAN3610A	Orange	Common Anode; Right Hand Decimal
MAN3620A	Orange	Common Anode; Left Hand Decimal
MAN3630A	Orange	Common Cathode; Right Hand Decimal
MAN3640A	Orange	Common Cathode; Left Hand Decimal
MAN3710A	Red	Common Anode; Right Hand Decimal
MAN3720A	Red	Common Anode; Left Hand Decimal
MAN3730A	Red	Common Cathode; Right Hand Decimal
MAN3740A	Red	Common Cathode; Left Hand Decimal
MAN3810A	Yellow	Common Anode; Right Hand Decimal
MAN3820A	Yellow	Common Anode; Left Hand Decimal
MAN3830A	Yellow	Common Cathode; Right Hand Decimal
MAN3840A	Yellow	Common Cathode; Left Hand Decimal

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN71A, 72A, 73A, 74A					
Luminous Intensity, digit average (See Note 1 and 3)	125	350		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		660		nm	
Spectral line half width		20		nm	
Forward voltage			2.0	V	$I_F = 20 \text{ mA}$
Segment			2.0	V	$I_F = 20 \text{ mA}$
Decimal point			2.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance				Ω	
Segment		2		Ω	$I_{pk} = 100 \text{ mA}$
Decimal point		2		Ω	$I_{pk} = 100 \text{ mA}$
Capacitance				pF	$V = 0$
Segment		35	80	pF	$V = 0$
Decimal point		35	80	pF	$V = 0$
Reverse current			100	μA	$V_R = 5.0 \text{ V}$
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$
MAN3810A, 3820A, 3840A					
Luminous Intensity, digit average (See Note 1 and 3)	450	1700		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		585		nm	
Spectral line half width		40		nm	
Forward voltage			3.0	V	$I_F = 20 \text{ mA}$
Segment			3.0	V	$I_F = 20 \text{ mA}$
Decimal point			3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance				Ω	
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance				pF	$V = 0$
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current			100	μA	$V_R = 5.0 \text{ V}$
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

Thermal resistance junction to free air, $R_{\theta JA}$	160°C/W
Wavelength temperature coefficient (case temperature)	-1.0%/°C
Forward voltage temperature coefficient	-1.5 mV/°C
Thermal resistance junction to free air, $R_{\theta JA}$	160°C/W
Wavelength temperature coefficient (case temperature)	-1.0%/°C
Forward voltage temperature coefficient	-2.0 mV/°C

1. The digit average luminous intensity is obtained by summing the luminous intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 3.3\%$ between all segments within a digit.
2. The curves in Figures 1, 2, 3, and 4 are normalized to the brightness at 25°C to indicate the relative luminous intensity over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments. Therefore, the luminous intensity of the decimal point is 3 times the luminous intensity of the segments since the area of the decimal point is 3 times the area of the average segment.
4. Leads of the device intended for use in high humidity or water may be used up to their boiling points.
5. For maximum brightness, the device should be operated at 25°C.
6. All displays are categorized for luminous intensity. The intensity category is marked on each part as a suffix letter to the part number.

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN3610A } MAN3620A } MAN3630A } MAN3640A }	Panelgraphic Scarlet 65 Homalite 100-1670	MAN71A } MAN72A } MAN73A } MAN74A }	Panelgraphic Red 60 Homalite 100-1605
MAN3410A } MAN3420A } MAN3440A }	Panelgraphic Green 48 Homalite 100-1440 Green	MAN3810A } MAN3820A } MAN3840A }	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726 Panelgraphic Grey 10 Homalite 100-1266 Grey

ABSOLUTE MAXIMUM RATINGS

	HIGH EFF. GREEN MAN3410A MAN3420A MAN3440A	RED MAN71A MAN72A MAN73A MAN74A	MAN73A
Power dissipation at 25°C ambient	600 mW	480 mW	300 mW
Derate linearly from 50°C	-12 mW/°C	-6.9 mW/°C	-4.29 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	240 mA	240 mA	150 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

	YELLOW MAN3810A MAN3820A MAN3840A	ORANGE MAN3610A MAN3620A MAN3640A	MAN3630A
Power dissipation at 25°C ambient	600 mW	600 mW	375 mW
Derate linearly from 50°C	-10.3 mW/°C	-8.6 mW/°C	-5.36 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	200 mA	240 mA	150 mA
Per segment	25 mA	30 mA	30 mA
Decimal point	25 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA} 160°C/W
Wavelength temperature coefficient (case temperature) 1.0Å/°C
Forward voltage temperature coefficient -1.5 mV/°C

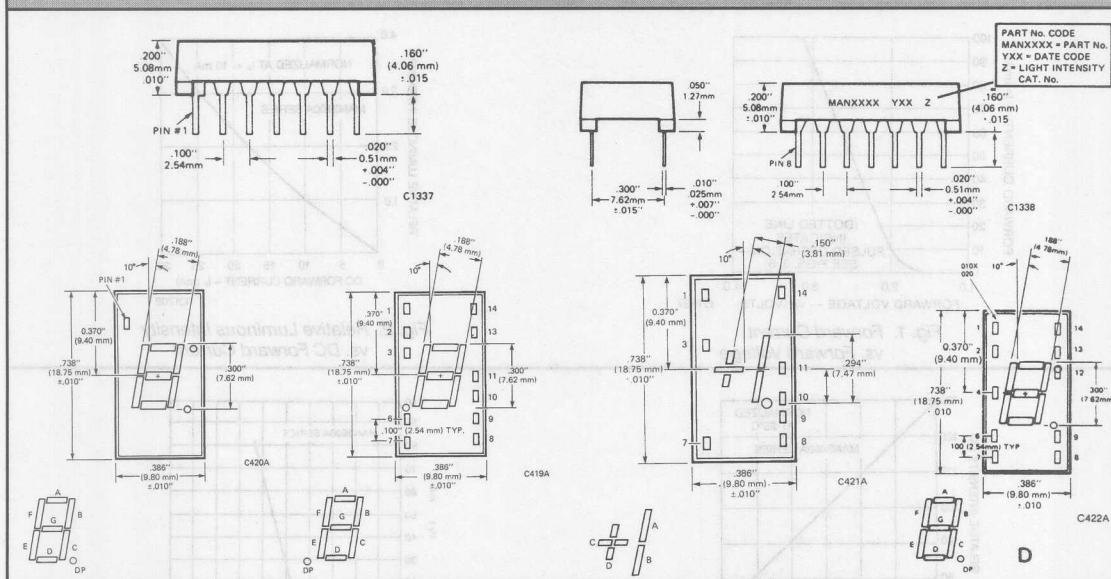
RED/ORANGE

Thermal resistance junction to free air Φ_{JA} 160°C/W
Wavelength temperature coefficient (case temperature) 1.0Å/°C
Forward voltage temperature coefficient -2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figures 3, 6, 9, and 12 is normalized to the brightness at 25°C to indicate the relative Luminous Intensity over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.
4. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
5. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
6. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

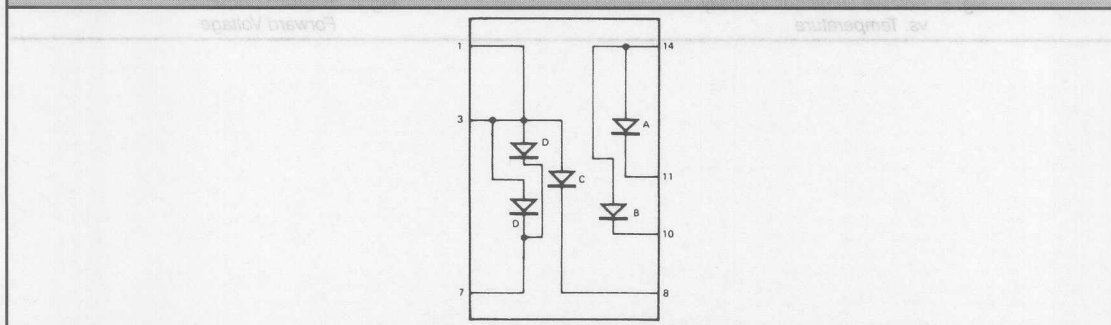
PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

Pin No.	ELECTRICAL CONNECTIONS			
	A MAN3410A, 3610A, 71A, 3810A	B MAN3420A, 72A, 3620A, 3820A	C MAN3630A, 73A	D MAN3440A, 3640A, 74A, 3840A
1	Cathode A	Cathode A	Anode C, D	Anode F
2	Cathode F	Cathode F	No Pin	Anode G
3	Common Anode	Common Anode	Anode C, D	No Pin
4	No Pin	No Pin	No Pin	Common Cathode
5	No Pin	No Pin	No Pin	No Pin
6	No Connection	Cathode D.P.	No Pin	Anode E
7	Cathode E	Cathode E	Cathode D	Anode D
8	Cathode D	Cathode D	Cathode C	Anode C
9	Cathode D.P.	No Connection	No Connection	Anode D.P.
10	Cathode C	Cathode C	Cathode B	No Pin
11	Cathode G	Cathode G	Cathode A	No Pin
12	No Pin	No Pin	No Pin	Common Cathode
13	Cathode B	Cathode B	No Pin	Anode B
14	Common Anode	Common Anode	Anode A, B	Anode A

ELECTRICAL SCHEMATIC



TYPICAL CHARACTERISTIC CURVES

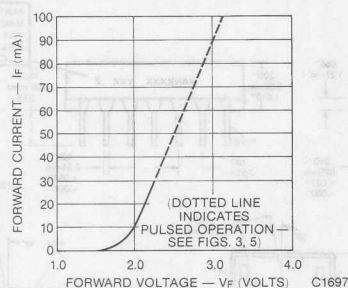


Fig. 1. Forward Current vs. Forward Voltage

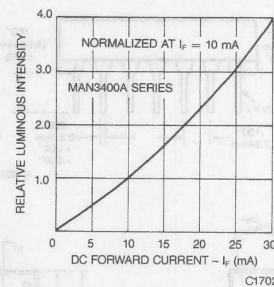


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

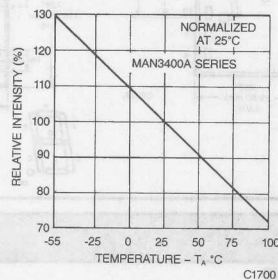


Fig. 3. Relative Luminous Intensity vs. Temperature

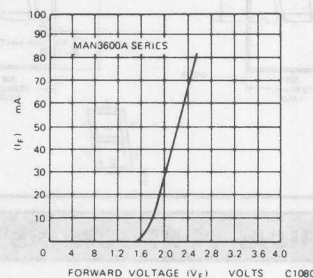


Fig. 4. Forward Current vs. Forward Voltage

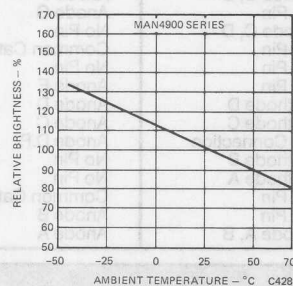


Fig. 5. Relative Luminous Intensity vs. Temperature

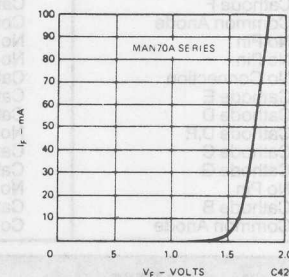


Fig. 6. Forward Current vs. Forward Voltage

TYPICAL CHARACTERISTIC CURVES (Cont'd)

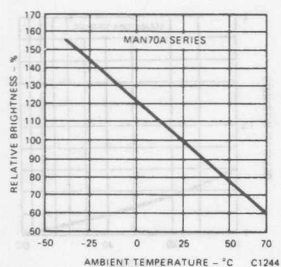


Fig. 7. Relative Luminous Intensity vs. Temperature

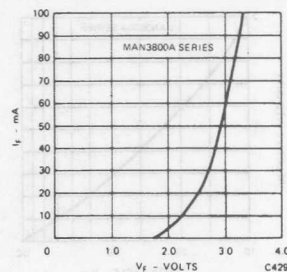


Fig. 8. Forward Current vs. Forward Voltage

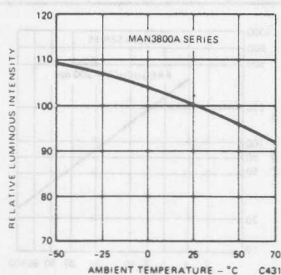


Fig. 9. Relative Luminous Intensity vs. Temperature

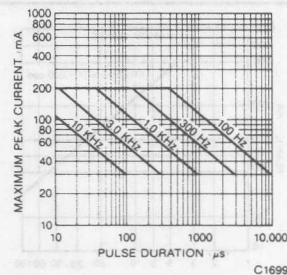


Fig. 10. Maximum Peak Current vs. Pulse Duration

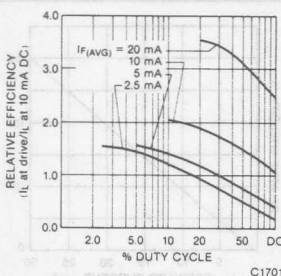


Fig. 11. Relative Efficiency vs. Duty Cycle

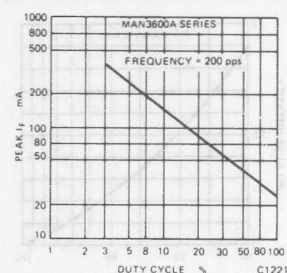


Fig. 12. Max Peak Current vs. Duty Cycle

TYPICAL CHARACTERISTIC CURVES (Cont'd)

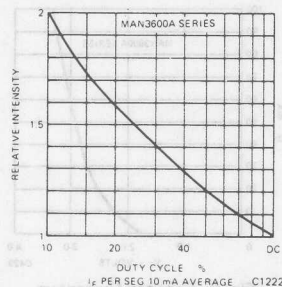


Fig. 13. Luminous Intensity vs. Duty Cycle

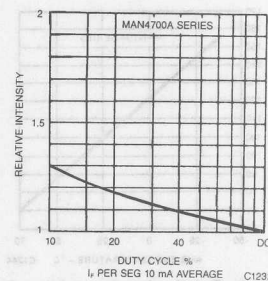


Fig. 14. Luminous Intensity vs. Duty Cycle

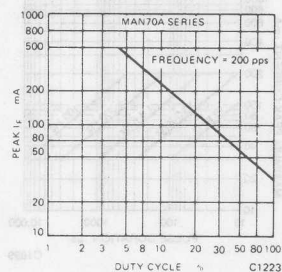


Fig. 15. Max Peak Current vs. Duty Cycle

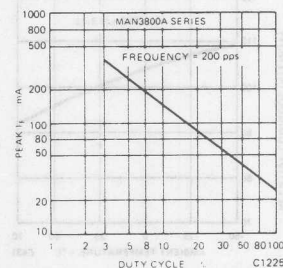


Fig. 16. Max Peak Current vs. Duty Cycle

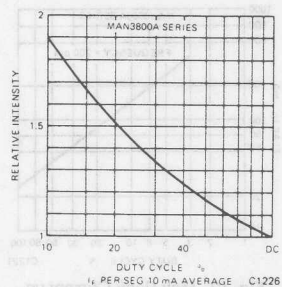


Fig. 17. Luminous Intensity vs. Duty Cycle

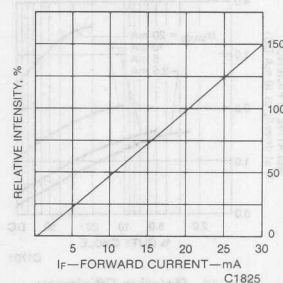
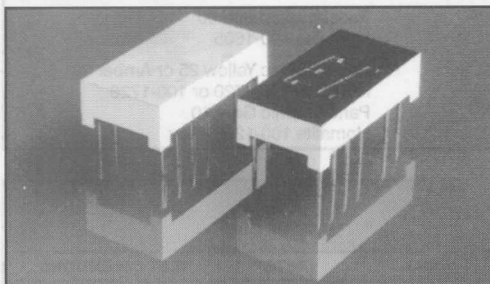


Fig. 18. Relative Luminous Intensity vs. Forward Current

**HIGH EFFICIENCY GREEN MAN3480A
ORANGE MAN3680A**

**RED MAN78A
YELLOW MAN3880A
HIGH EFFICIENCY RED MAN3980A**



DESCRIPTION

The MAN3480A, MAN3680A, MAN78A, MAN3880A and MAN3980A are common cathode displays which provide a choice of color of LED displays. They are pin and functional replacements for the 0.300-inch Hewlett-Packard common cathode displays. The series is complementary to the MAN3400A, MAN3600A, MAN70A, MAN3800A and MAN3900A families of displays. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Yellow and High Efficiency Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

FEATURES

- Hewlett-Packard compatible common cathode displays
- Red, Yellow, Green, Orange and High Efficiency Red
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard 10 pin dual-in-line package configuration
- Wide viewing angle... 150°

APPLICATIONS

- Digital readout displays
- Instrument panels
- Point of sale terminals
- Calculators
- Digital clocks

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
MAN3480A	High Efficiency Green	Common Cathode; Right Hand Decimal
MAN3680A	Orange	Common Cathode; Right Hand Decimal
MAN78A	Red	Common Cathode; Right Hand Decimal
MAN3880A	Yellow	Common Cathode; Right Hand Decimal
MAN3980A	High Efficiency Red	Common Cathode; Right Hand Decimal

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN3480A	Panelgraphic Green 48 Homalite 100-1440 Green	MAN3980A MAN78A	Panelgraphic Red 60 Homalite 100-1605
MAN3680A	Panelgraphic Scarlet 65 Homalite 100-1670	MAN3880A	Panelgraphic Yellow 25 or Amber 23 Homalite 100-1720 or 100-1726 Panelgraphic Grey 10 Homalite 100-1266 Grey

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN3480A					
Luminous Intensity, digit average (See Notes 1 and 3)	750 900	3200 4000		μcd μcd	$I_F = 10 \text{ mA}$ $I_F = 60 \text{ mA peak, 1:6 DF}$
Peak emission wavelength		562		nm	
Spectral line half width		30		nm	
Forward voltage					
Segment		2.2	3.0	V	$I_F = 20 \text{ mA}$
Decimal point		2.2	3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		12		Ω	$I_F = 20 \text{ mA}$
Decimal point		12		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		40		pF	$V = 0$
Decimal point		40		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$
MAN3680A					
Luminous Intensity, digit average (See Note 1 and 3)	510	1800		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20 \text{ mA}$
Decimal point			2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN78A					
Luminous Intensity, digit average (See Note 1 and 3)	125	350		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		660		nm	
Spectral line half width		20		nm	
Forward voltage					
Segment			2.0	V	$I_F = 20 \text{ mA}$
Decimal point			2.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		2		Ω	$I_{pk} = 100 \text{ mA}$
Decimal point		2		Ω	$I_{pk} = 100 \text{ mA}$
Capacitance					
Segment		35	80	pF	$V = 0$
Decimal point		35	80	pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$
MAN3880A					
Luminous Intensity, digit average (See Note 1 and 3)	450	1700		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		585		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			3.0	V	$I_F = 20 \text{ mA}$
Decimal point			3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$
MAN3980A					
Luminous Intensity, digit average (See Note 1 and 3)	450	1900		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20 \text{ mA}$
Decimal point			2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

ABSOLUTE MAXIMUM RATINGS

	HIGH EFF. GREEN	RED	ORANGE YELLOW HIGH EFF. RED
	MAN3480A	MAN78A	MAN3680A MAN3880A MAN3980A
Power dissipation at 25°C ambient	600 mW	480 mW	600 mW
Derate linearly from 50°C	-12 mW/°C	-6.9 mW/°C	-10.3 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	240 mA	240 mA	200 mA
Per segment	30 mA	30 mA	25 mA
Decimal point	30 mA	30 mA	25 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-1.5 mV/°C

RED/ORANGE/HIGH EFFICIENCY RED

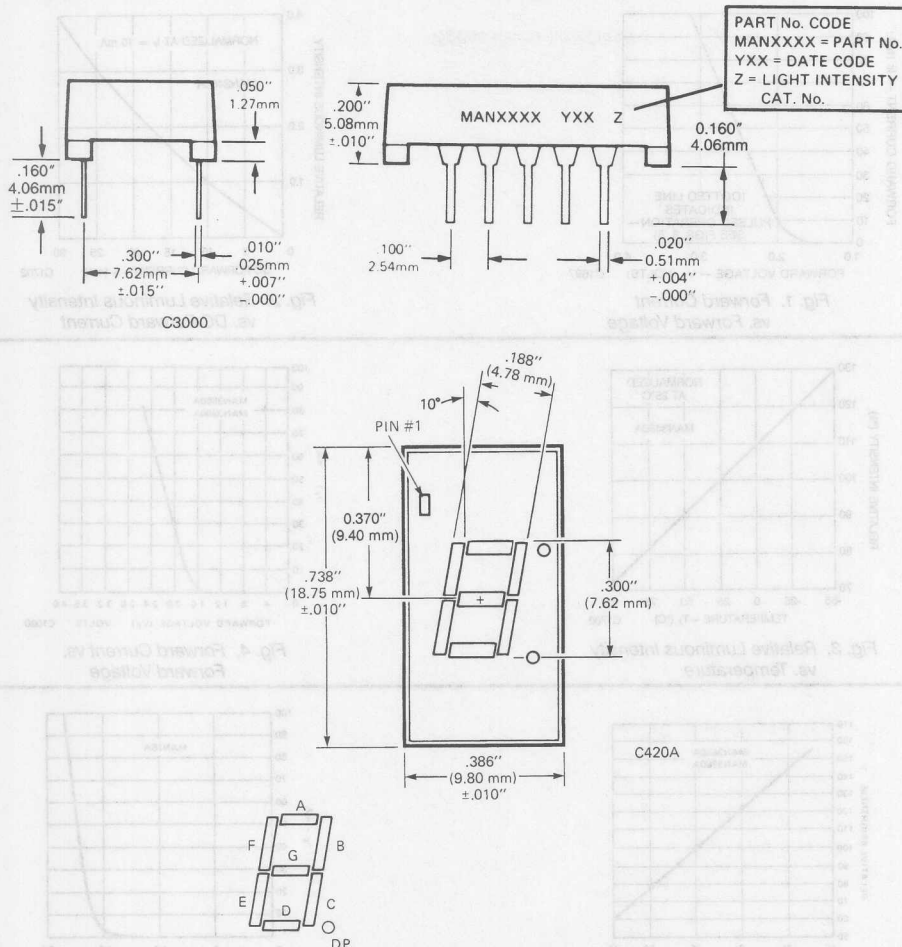
Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figures 3, 6, 9, and 12 is normalized to the brightness at 25°C to indicate the relative Luminous Intensity over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.
4. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
5. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
6. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

MAN78A MAN3480A MAN3680A MAN3880A MAN3980A

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS
1	Common Cathode
2	Anode F
3	Anode G
4	Anode E
5	Anode D
6	Common Cathode
7	Anode D.P.
8	Anode C
9	Anode B
10	Anode A

TYPICAL CHARACTERISTIC CURVES

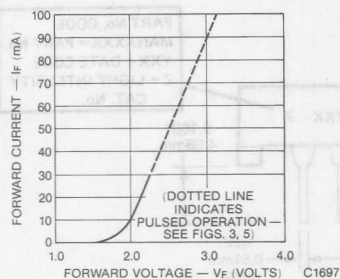


Fig. 1. Forward Current vs. Forward Voltage

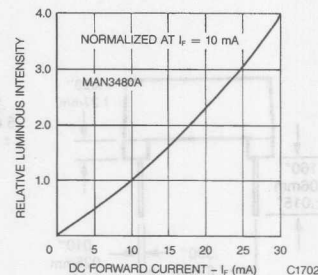


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

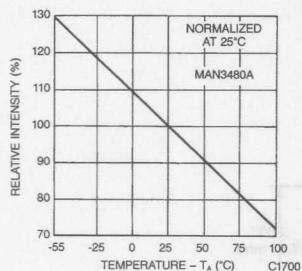


Fig. 3. Relative Luminous Intensity vs. Temperature

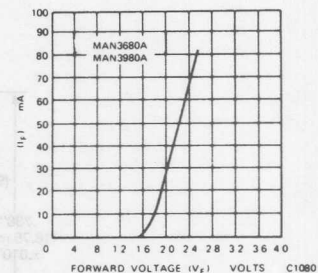


Fig. 4. Forward Current vs. Forward Voltage

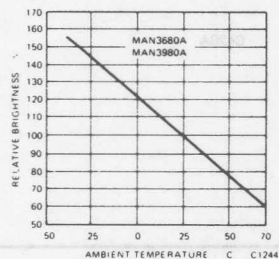


Fig. 5. Relative Luminous Intensity vs. Temperature

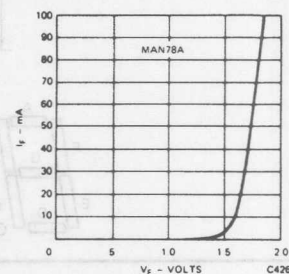


Fig. 6. Forward Current vs. Forward Voltage

MAN78A MAN3480A MAN3680A MAN3880A MAN3980A

TYPICAL CHARACTERISTIC CURVES (Cont'd)

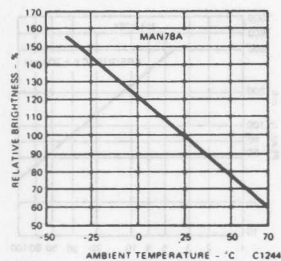


Fig. 7. Relative Luminous Intensity vs. Temperature

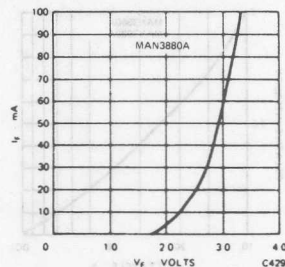


Fig. 8. Forward Current vs. Forward Voltage

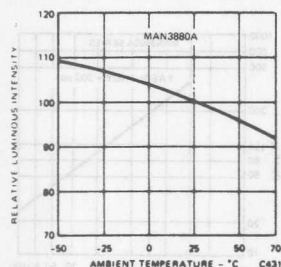


Fig. 9. Relative Luminous Intensity vs. Temperature

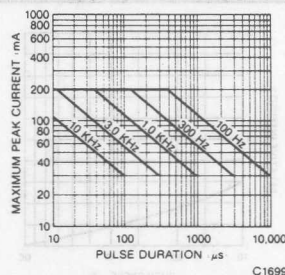


Fig. 10. Maximum Peak Current vs. Pulse Duration

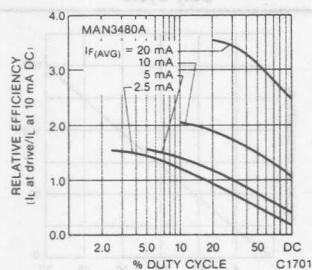


Fig. 11. Relative Efficiency vs. Duty Cycle

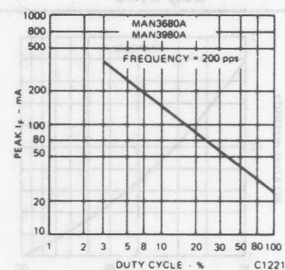


Fig. 12. Max Peak Current vs. Duty Cycle

TYPICAL CHARACTERISTIC CURVES (Cont'd)

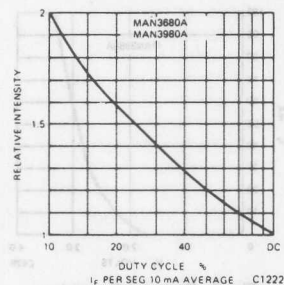


Fig. 13. Luminous Intensity vs. Duty Cycle

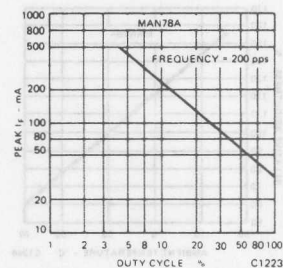


Fig. 14. Max Peak Current vs. Duty Cycle

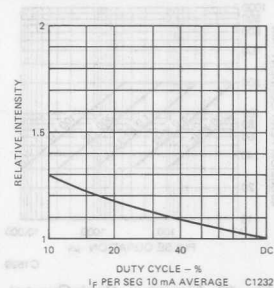


Fig. 15. Luminous Intensity vs. Duty Cycle

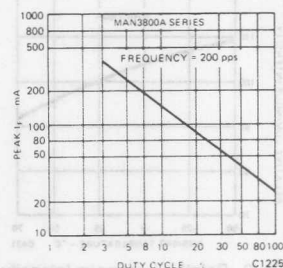


Fig. 16. Max Peak Current vs. Duty Cycle

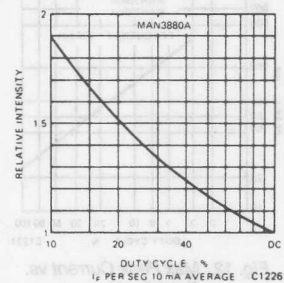


Fig. 17. Luminous Intensity vs. Duty Cycle

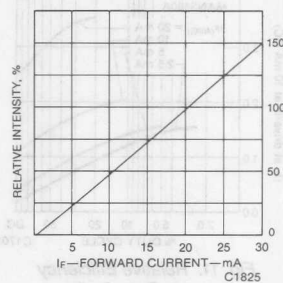
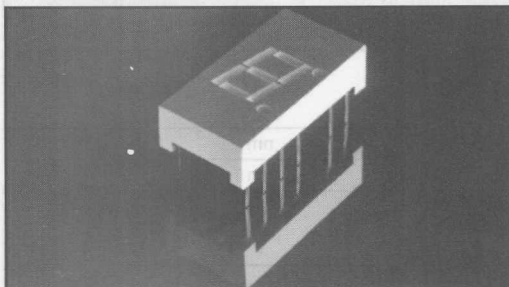


Fig. 18. Relative Luminous Intensity vs. Forward Current

HIGH EFFICIENCY RED MAN3900A SERIES



DESCRIPTION

The MAN3900A Series is a High Efficiency Red LED display. Standard units are also available in Red, Green, Orange and Yellow, with common anode right hand decimal, common anode left hand decimal, and common cathode right hand decimal. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Units are constructed with Red face and segment color.

FEATURES

- Common anode or common cathode models
- High Efficiency Red
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard dual-in-line package configuration
- Wide angle viewing . . . 150°
- These devices have a Red face and Red segments

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks

MODEL NUMBERS

PART NUMBER	COLOR	PACKAGE	DESCRIPTION	PIN OUT SPECIFICATION
MAN3910A	High Efficiency Red	A	Common Anode; Right Hand Decimal	A
MAN3920A	High Efficiency Red	B	Common Anode; Left Hand Decimal	B
MAN3940A	High Efficiency Red	C	Common Cathode; Right Hand Decimal	C
MAN3980A	High Efficiency Red	D	Common Cathode; Right Hand Decimal	D

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN3910A	
MAN3920A	Panelgraphic Scarlet 65
MAN3940A	Homalite 100-1670
MAN3980A	

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITONS
MAN3910A, 3920A, 3940A, 3980A					
Luminous Intensity, digit average (See Note 1 and 3)	450	1900		μ cd	$I_F = 10$ mA
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20$ mA
Decimal point			2.5	V	$I_F = 20$ mA
Dynamic resistance					
Segment		26		Ω	$I_F = 20$ mA
Decimal point		26		Ω	$I_F = 20$ mA
Capacitance					
Segment		35		pF	V=0
Decimal point		35		pF	V=0
Reverse current					
Segment			100	μ A	$V_R = 5.0$ V
Decimal point			100	μ A	$V_R = 5.0$ V

ABSOLUTE MAXIMUM RATINGS

MAN3910A, MAN3920A, MAN3940A, MAN3980A

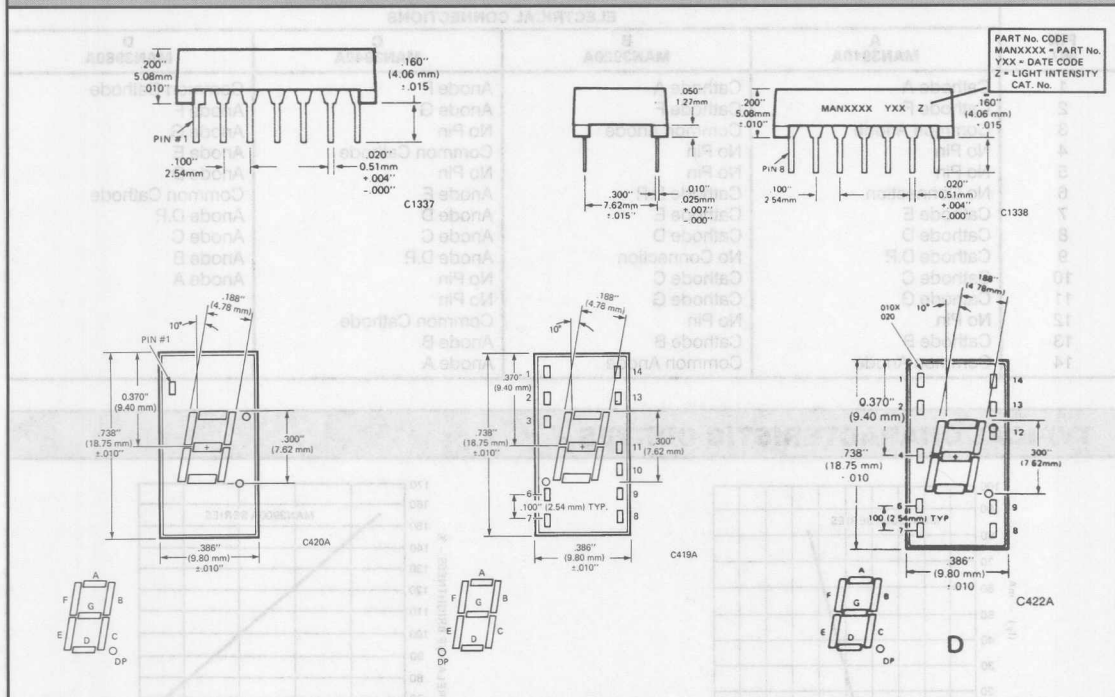
Power dissipation at 25°C ambient	600 mW
Derate linearly from 50°C	-8.6 mW/°C
Storage and operating temperature	-40°C to +85°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.

TYPICAL THERMAL CHARACTERISTICS

HIGH EFFICIENCY RED

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

PACKAGE DIMENSIONS



NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative Luminous Intensity over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.
4. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
5. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used to their boiling points.
6. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

ELECTRICAL CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN3910A	B MAN3920A	C MAN3940A	D MAN3980A
1	Cathode A	Cathode A	Anode F	Common Cathode
2	Cathode F	Cathode F	Anode G	Anode F
3	Common Anode	Common Anode	No Pin	Anode G
4	No Pin	No Pin	Common Cathode	Anode E
5	No Pin	No Pin	No Pin	Anode D
6	No Connection	Cathode D.P.	Anode E	Common Cathode
7	Cathode E	Cathode E	Anode D	Anode D.P.
8	Cathode D	Cathode D	Anode C	Anode C
9	Cathode D.P.	No Connection	Anode D.P.	Anode B
10	Cathode C	Cathode C	No Pin	Anode A
11	Cathode G	Cathode G	No Pin	
12	No Pin	No Pin	Common Cathode	
13	Cathode B	Cathode B	Anode B	
14	Common Anode	Common Anode	Anode A	

TYPICAL CHARACTERISTIC CURVES

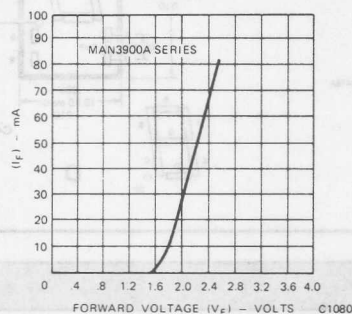


Fig. 1. Forward Current vs. Forward Voltage

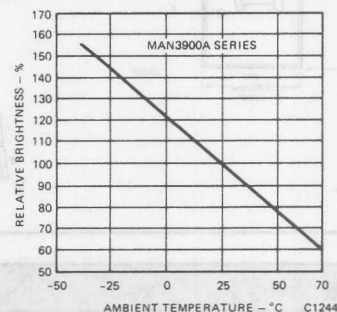


Fig. 2. Relative Luminous Intensity vs. Temperature

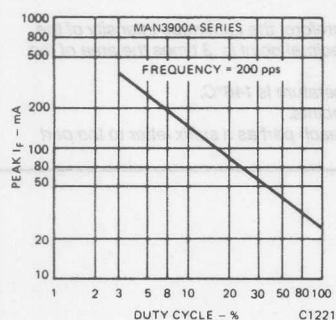


Fig. 3. Max Peak Current vs. Duty Cycle

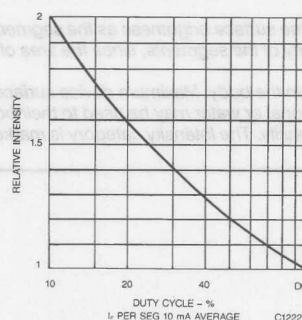


Fig. 4. Luminous Intensity vs. Duty Cycle

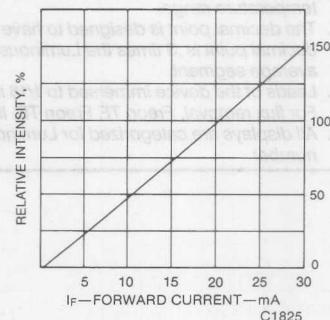
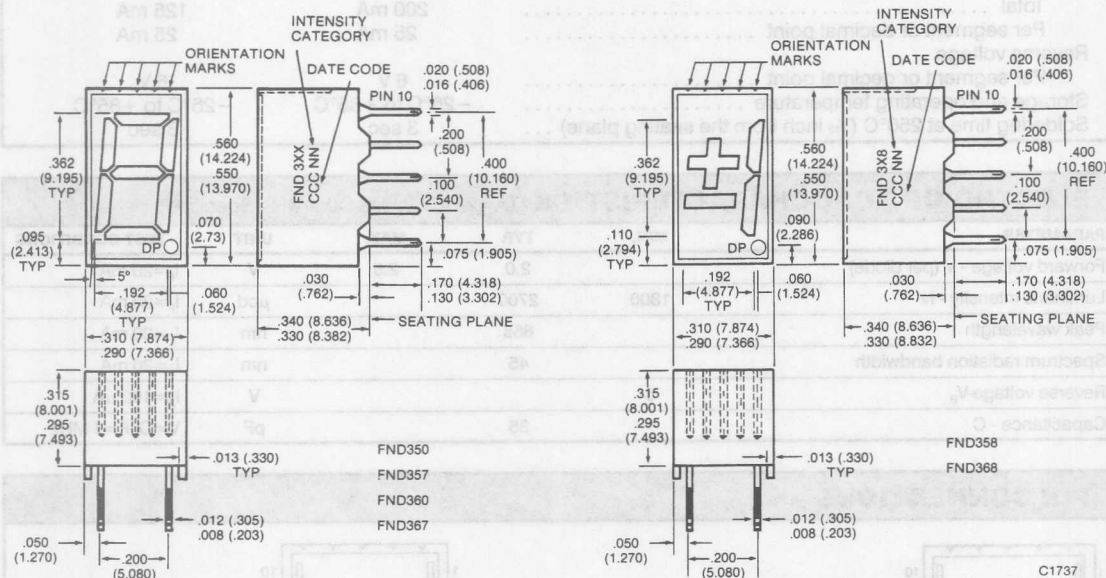


Fig. 5. Relative Luminous Intensity vs. Forward Current

HIGH EFFICIENCY RED FND310C FND317C FND318C

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MM (INCH)
2. TOLERANCE ARE ± 0.010 INCH UNLESS OTHERWISE SPECIFIED

DESCRIPTION

The FND310C, FND317C and FND318D are high efficiency red GaP 7-segment displays with nominal 0.362" digit height. Reflector cap, PCB and encapsulant are used in the construction of these FND3XXCs.

FEATURES

- Exactly pin and package compatible with FND3XX
- Compact — 10 digits in 3-inch panel width
- Wide viewing angle
- Right-hand decimal configuration
- Categorized for luminous intensity
- Rugged encapsulated plastic construction

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION
FND310C	Hi. Eff. Red	Common anode seven segment display
FND317C	Hi. Eff. Red	Common cathode seven segment display
FND318C	Hi. Eff. Red	Common cathode ± 1 overflow display

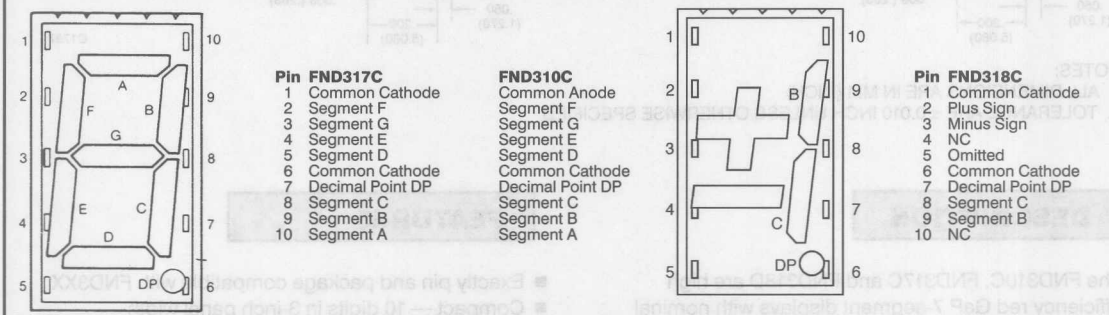
ABSOLUTE MAXIMUM RATINGS

	FND310C/317C	FND318C
Power dissipation at 25°C ambient	500 mW	320 mW
Continuous forward current		
Total	200 mA	125 mA
Per segment or decimal point	25 mA	25 mA
Reverse voltage		
Per segment or decimal point	6 V	6 V
Storage and operating temperature	-25°C to +85°C	-25°C to +85°C
Soldering time at 250°C (1/16 inch from the seating plane) ...	3 sec	3 sec

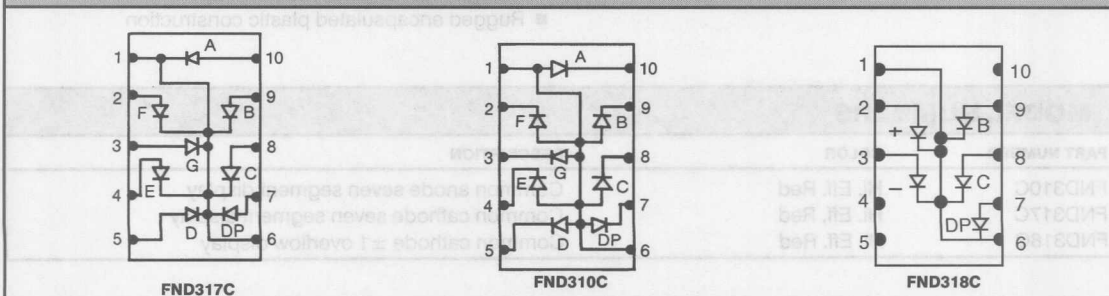
ELECTRO-OPTICAL CHARACTERISTICS (TA=25°C Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Forward voltage - V (per diode)		2.0	2.5	V	I _F =20 mA
Luminous intensity - I _v	1800	2700		μcd	I _F =20 mA
Peak wavelength		655		nm	I _F =20 mA
Spectrum radiation bandwidth		45		nm	I _F =20 mA
Reverse voltage-V _R	5			V	I _R =100 μA
Capacitance - C		35		pF	V=0, F=1 MHz

PIN CONNECTIONS



ELECTRICAL SCHEMATIC



TYPICAL ELECTRO - OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

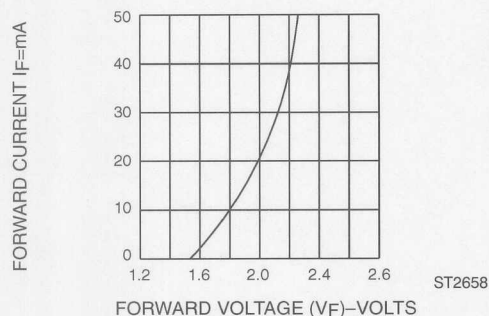


Fig. 1 Forward Current vs. Forward Voltage

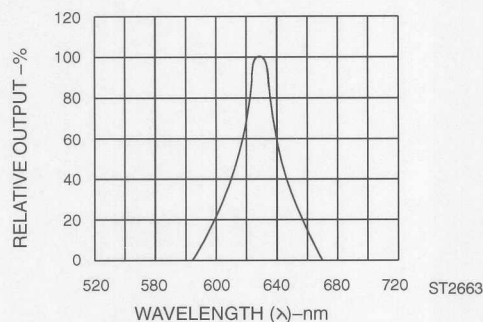


Fig. 2 Spectral Response

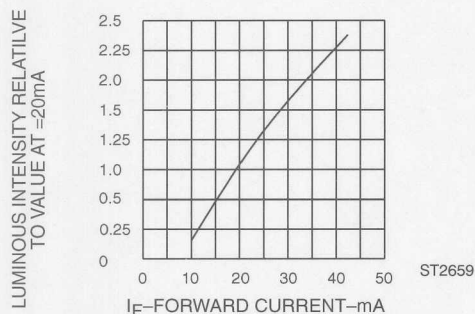


Fig. 3 Relative Luminous Intensity vs. Forward Current

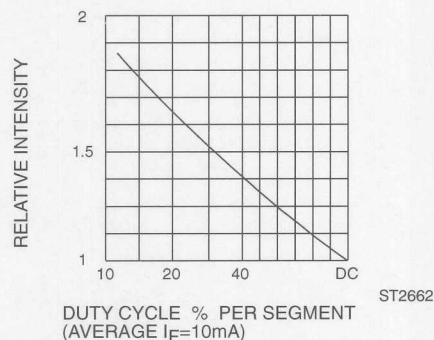


Fig. 5 Luminous Intensity vs. Duty Cycle

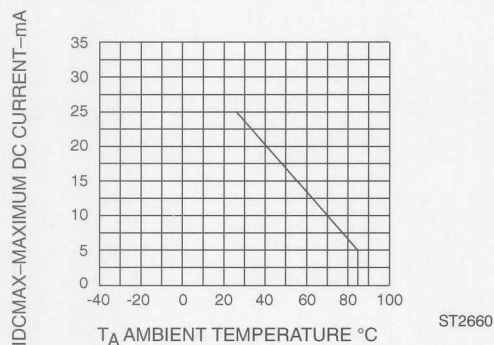


Fig. 4 Maximum Allowable DC Current Per Segment vs. a Function of Ambient Temperature

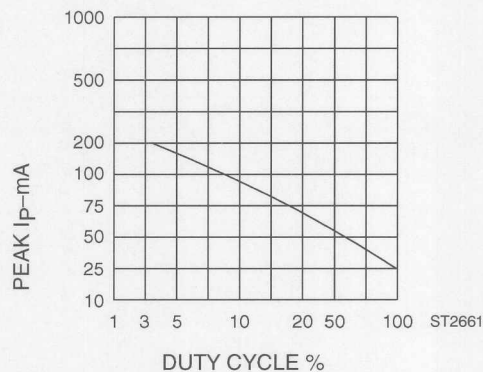


Fig. 6 Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{KHz}$)

Clean the displays only in water, isopropanol, ethanol, freon TF or TE (or equivalent)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

Fig. 1 Forward Current vs. Forward Voltage

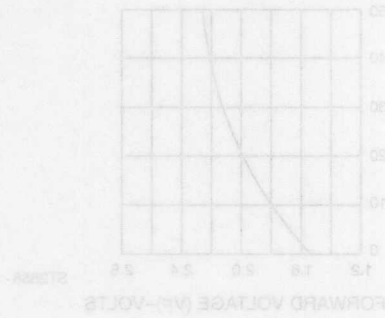


Fig. 2 Spectral Response

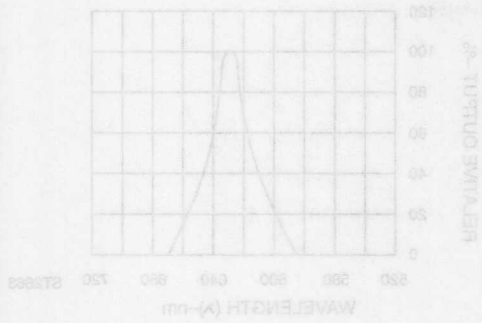


Fig. 3 Relative Luminous Intensity vs. Forward Current

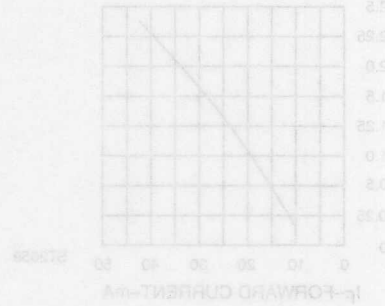


Fig. 4 Maximum Allowable DC Current vs. Ambient Temperature

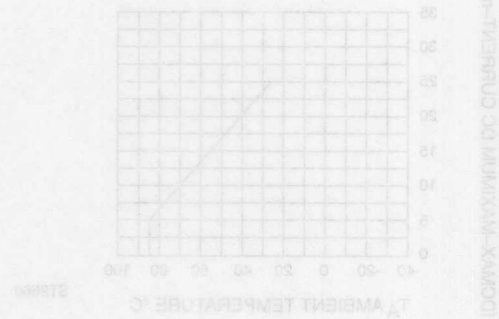


Fig. 5 Luminous Intensity vs. Duty Cycle

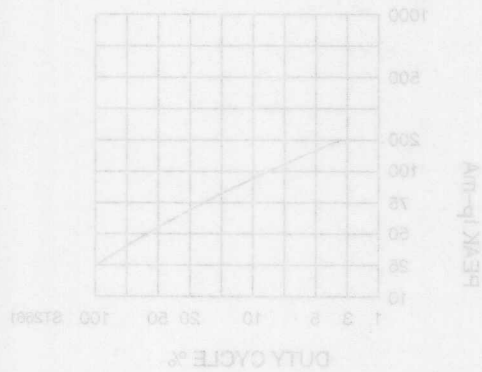
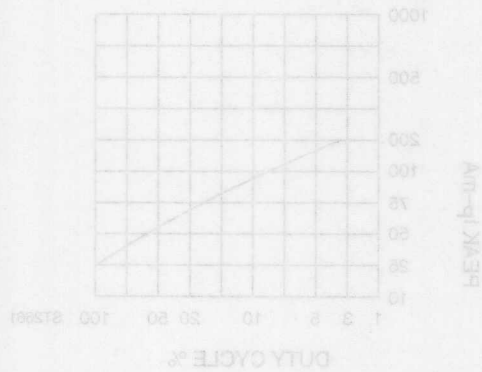
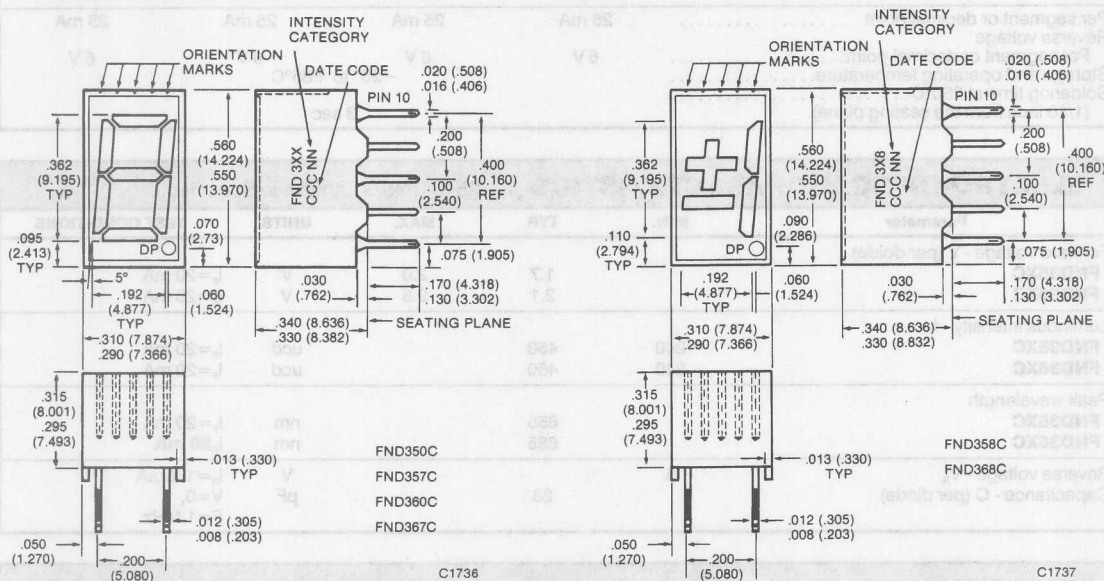


Fig. 6 Max Peak Current vs. Duty Cycle



**RED FND350C FND357C FND358C
HI-BRITE RED FND360C FND367C FND368C**

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MM (INCH)
2. TOLERANCES ARE ± 0.010 INCH UNLESS OTHERWISE SPECIFIED

DESCRIPTION

The FND35XC are red GaAsP/GaAs displays and FND36XC are hi-brite GaP/GaP displays. Both series are of nominal size of 0.362" in digit height and are of right hand decimal configuration.

FEATURES

- Exactly pin and package compatible with FND3XX.
- Compact—10 digits in 3 inch panel width
- Right hand decimal configuration
- Wide viewing angle
- Categorized for luminous intensity
- Rugged encapsulated plastic construction

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION
FND350C	Red	Common anode seven segment display
FND357C	Red	Common cathode seven segment display
FND358C	Red	Common cathode ± 1 overflow display
FND360C	Hi-brite Red	Common anode seven segment display
FND367C	Hi-brite Red	Common cathode seven segment display
FND368C	Hi-brite Red	Common cathode ± 1 overflow display

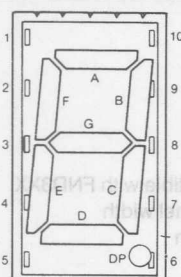
ABSOLUTE MAXIMUM RATINGS

	FND350C FND357C	FND358C	FND360C FND367C	FND368C
Power dissipation at 25°C ambient	400 mW	250 mW	320 mW	200mW
Continuous forward current				
Total	200 mA	125 mA	200 mA	125 mA
Per segment or decimal point	25 mA	25 mA	25 mA	25 mA
Reverse voltage				
Per segment or decimal point	6 V	6 V	6 V	6 V
Storage and operating temperature	-25° to +85°C			
Soldering time at 250°C	3 sec			
(1/16 inch from the seating plane)				

ELECTRO-OPTICAL CHARACTERISTICS (T_A=25°C Unless Otherwise Specified)

Parameter	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage - V (per diode)					
FND35XC		1.7	2.0	V	I _F =20 mA
FND36XC		2.1	2.6	V	I _F =20 mA
Luminous intensity - I _v					
FND35XC	240	450		ucd	I _F =20 mA
FND36XC	240	450		ucd	I _F =20 mA
Peak wavelength					
FND35XC		655		nm	I _F =20 mA
FND36XC		655		nm	I _F =20 mA
Reverse voltage - V _R	5			V	I _R =100 μA
Capacitance - C (per diode)		23		pF	V=0, F=1 MHz

PIN CONNECTIONS

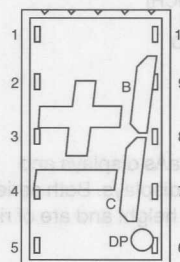


**FND357C
FND367C**

- 1 Common Cathode
- 2 Segment F
- 3 Segment G
- 4 Segment E
- 5 Segment D
- 6 Common Cathode
- 7 Decimal Point DP
- 8 Segment C
- 9 Segment B
- 10 Segment A

**FND350C
FND360C**

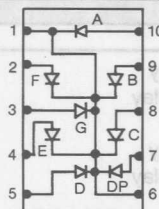
- Common Anode
- Segment F
- Segment G
- Segment E
- Segment D
- Common Anode
- Decimal Point DP
- Segment C
- Segment B
- Segment A



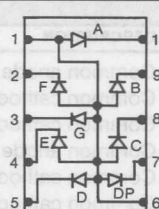
**FND358C
FND368C**

- 1 Common Cathode
- 2 Plus Sign
- 3 Minus Sign
- 4 NC
- 5 Omitted
- 6 Common Cathode
- 7 Decimal Point DP
- 8 Segment C
- 9 Segment B
- 10 NC

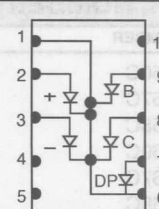
ELECTRICAL SCHEMATIC



**FND357C
FND367C**



**FND350C
FND360C**



**FND358C
FND368C**

TYPICAL ELECTRO - OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

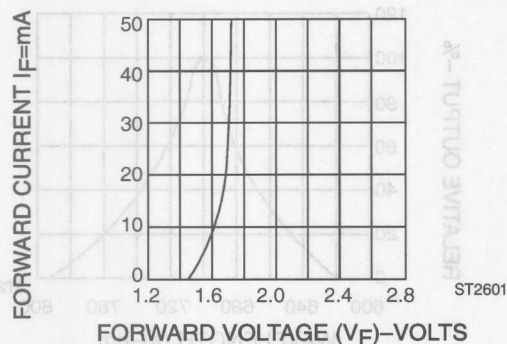


Fig. 1 Forward Current vs. Forward Voltage

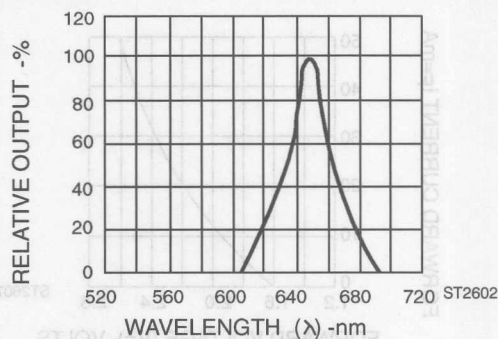


Fig. 2 Spectral Response

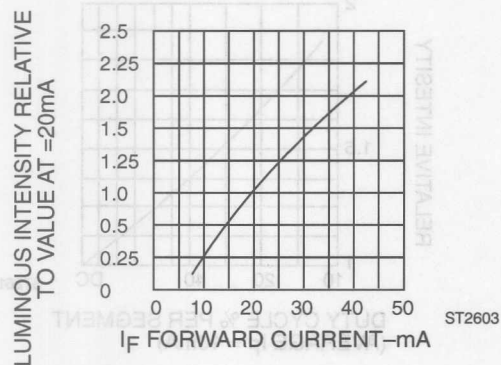


Fig. 3 Relative Luminous Intensity vs. Forward Current

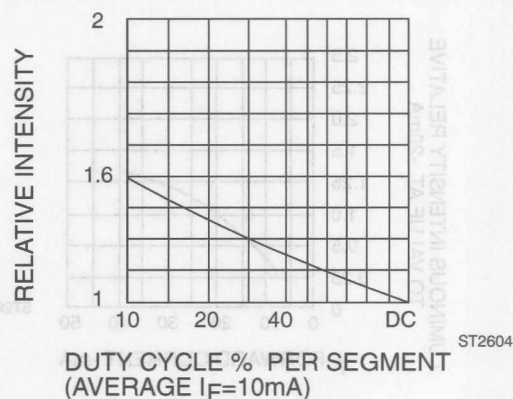


Fig. 5 Luminous Intensity vs. Duty Cycle

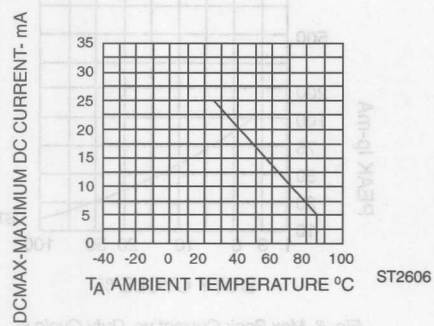


Fig. 4 Maximum Allowable DC Current Per Segment vs. A Function Of Ambient Temperature

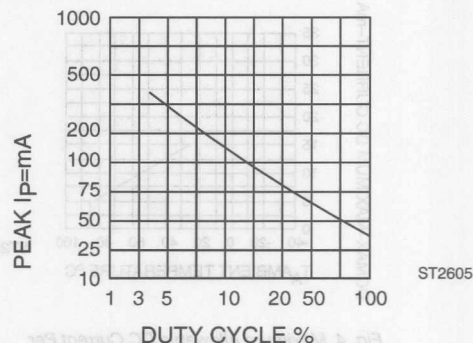


Fig. 6 Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)

Clean the displays only in water, isopropanol, ethanol, freon TF or TE (or equivalent)

TYPICAL ELECTRO - OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

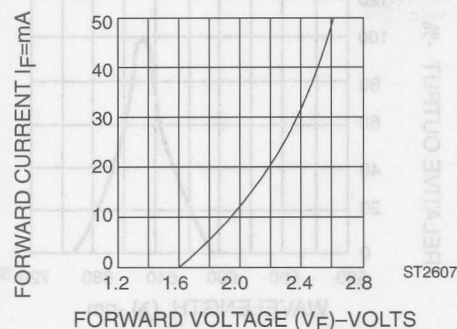


Fig. 1 Forward Current vs. Forward Voltage

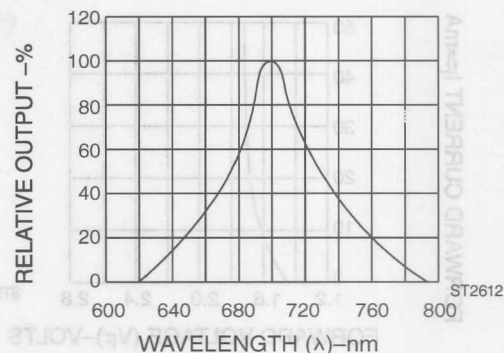


Fig. 2 Spectral Response

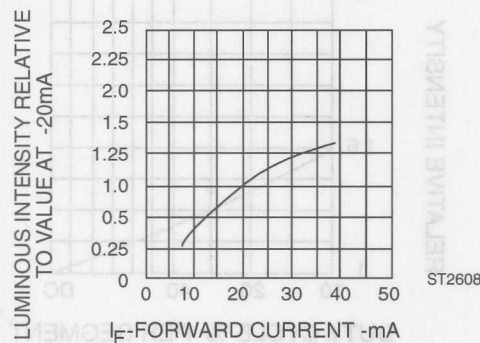


Fig. 3 Relative Luminous Intensity vs. Forward Current

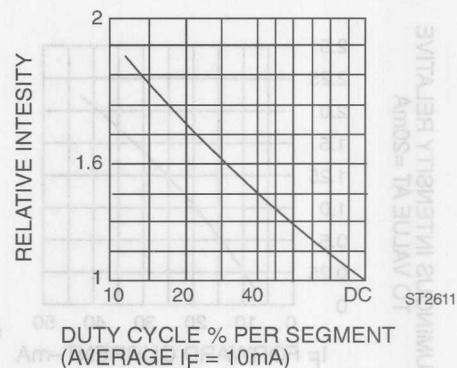


Fig. 5 Luminous Intensity vs. Duty Cycle

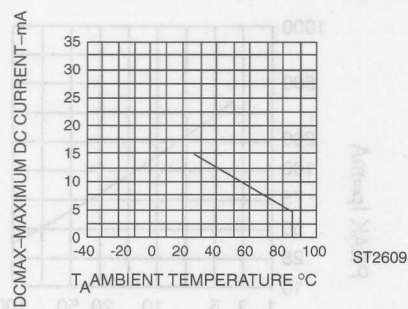


Fig. 4 Maximum Allowable DC Current Per Segment vs. A Function Of Ambient Temperature

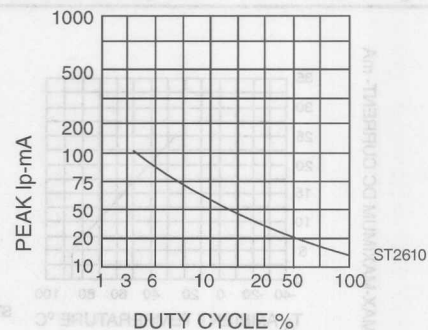
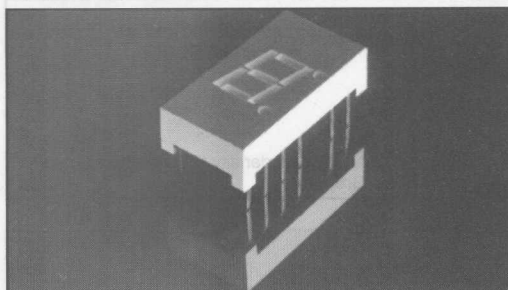


Fig. 6 Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)

Clean the displays only in water, isopropanol, ethanol, freon TF or TE (or equivalent)

**HIGH EFFICIENCY GREEN MAN4400A SERIES
ORANGE MAN4600A SERIES
RED MAN4700A SERIES**



DESCRIPTION

The MAN4400, MAN4600, MAN4700 and MAN4800 Series provides superior brightness in a choice of color LED displays. Standard units are available in Red, Green, and Orange. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. The Green displays are constructed with Grey face and neutral segment color. Red displays have Black faces and Red segment color. Others have face and segment color corresponding to the emitted light.

FEATURES

- Common anode or common cathode models
- Red, Green and Orange
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard 14 pin dual-in-line package configuration
- Wide angle viewing . . . 150°
- Package size and lead configuration is the same as MAN50A/3600A/70A/80A Series

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks
- High ambient light conditions

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN4410A	Green	Common Anode; Right Hand Decimal	A	A
MAN4440A	Green	Common Cathode; Right Hand Decimal	A	C
MAN4610A	Orange	Common Anode; Right Hand Decimal	A	A
MAN4630A	Orange	Common Anode; Overflow ± 1 ; Right Hand Decimal	B	B
MAN4640A	Orange	Common Cathode; Right Hand Decimal	A	C
MAN4705A	Red	Universal (CA or CC) Overflow ± 1 ; Right Hand Decimal	B	D
MAN4710A	Red	Common Anode; Right Hand Decimal	A	A
MAN4740A	Red	Common Cathode; Right Hand Decimal	A	C

RECOMMENDED OPTICAL FILTER

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN4410A } MAN4440A }	Panelgraphic Green 48	MAN4705A } MAN4710A } MAN4740A }	Panelgraphic Red 60 Homalite 100-1605
MAN4610A } MAN4630A } MAN4640A }	Panelgraphic Scarlet 65 Homalite 100-1670		

NOTE: When using the Grey face MAN4480 or MAN4880 in situations of high ambient light, a neutral density filter can be used to achieve a greater contrast. The following or equivalent can be used: Panelgraphic Grey 10.

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4410A/4440A					
Luminous Intensity, digit average (See Note 1 and 3)	750	3200		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		562		nm	
Forward voltage					
Segment		2.2	3.0	V	$I_F = 20 \text{ mA}$
Decimal point		2.2	3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		12		Ω	$I_F = 20 \text{ mA}$
Decimal point		12		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		40		pF	$V = 0$
Decimal point		40		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$
MAN4610A/4630A/4640A					
Luminous Intensity, digit average (See Note 1 and 3)	510	1800		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		630		nm	
Forward voltage					
Segment		2.2	2.5	V	$I_F = 20 \text{ mA}$
Decimal point		2.2	2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4705A/4710A/4740A Luminous Intensity, digit average (See Note 1 and 3)	125	350		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		660		nm	
Forward voltage				V	$I_F = 20 \text{ mA}$
Segment		1.6	2.0	V	$I_F = 20 \text{ mA}$
Decimal point		1.6	2.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance				Ω	$I_F = 20 \text{ mA}$
Segment		2		Ω	$I_F = 20 \text{ mA}$
Decimal point		2		Ω	$I_F = 20 \text{ mA}$
Capacitance				pF	V=0
Segment		35	80	pF	V=0
Decimal point		35	80	pF	V=0
Reverse current				μA	$V_R = 5.0 \text{ V}$
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

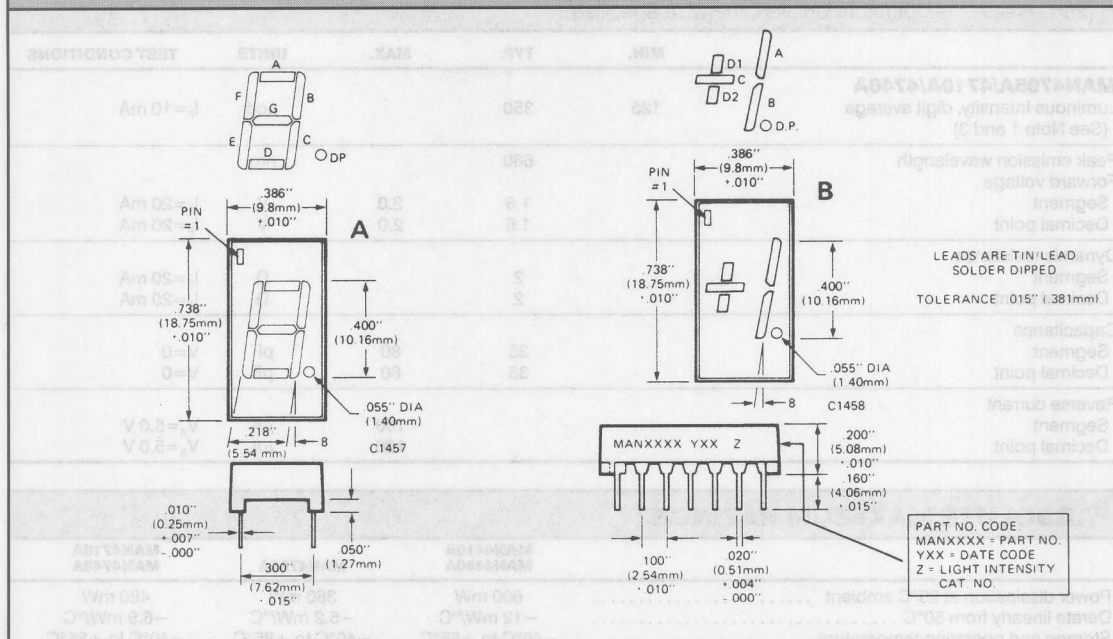
ABSOLUTE MAXIMUM RATINGS

	MAN4410A MAN4440A	MAN4705A	MAN4710A MAN4740A
Power dissipation at 25°C ambient	600 mW	360 mW	480 mW
Derate linearly from 50°C	-12 mW/°C	-5.2 mW/°C	-6.9 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	240 mA	180 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.	5 sec.	5 sec.
		MAN4630A	MAN4610A MAN4640A
Power dissipation at 25°C ambient		450 mW	600 mW
Derate linearly from 50°C		-6.4 mW/°C	-8.6 mW/°C
Storage and operating temperature		-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total		180 mA	240 mA
Per segment		30 mA	30 mA
Decimal point		30 mA	30 mA
Reverse voltage			
Per segment		6.0 V	6.0 V
Decimal point		6.0 V	6.0 V
Soldering time at 260°C (See Notes 4 and 5)		5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

GREEN/YELLOW	
Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-1.5 mV/°C
RED/ORANGE	
Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

PACKAGE DIMENSIONS



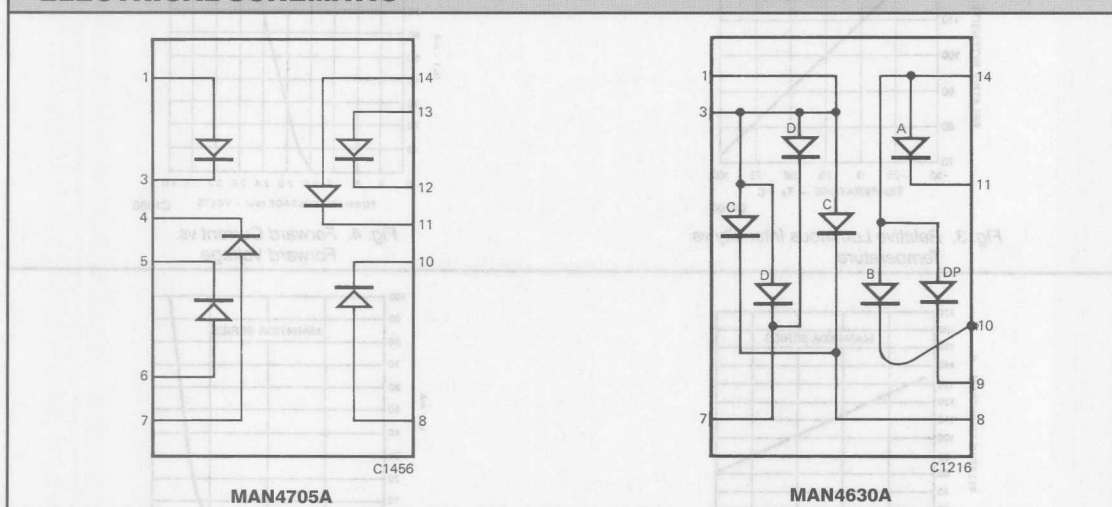
NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figures 3, 6, 9, and 12 is normalized to the brightness at 25°C to indicate the relative Luminous Intensity over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.
4. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
5. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
6. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

ELECTRICAL CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A MAN4410A/4610A/4710A	B MAN4630A	C MAN4440A/4640A/4740A	D MAN4705A
1	Cathode A	Anode C, D	Anode F	Anode D1
2	Cathode F	No Pin	Anode G	No Pin
3	Common Anode	Anode C, D	No Pin	Cathode D1
4	No Pin	No Pin	Common Cathode	Cathode C
5	No Pin	No Pin	No Pin	Cathode D2
6	No Pin	No Connection	Anode E	Anode D2
7	Cathode E	Cathode D	Anode D	Anode C
8	Cathode D	Cathode C	Anode C	Anode D.P.
9	Cathode D.P.	Cathode D.P.	Anode D.P.	No Pin
10	Cathode C	Cathode B	No Pin	Cathode D.P.
11	Cathode G	Cathode A	No Connection	Cathode B
12	No Pin	No Pin	Common Cathode	Cathode A
13	Cathode B	No Pin	Anode B	Anode A
14	Common Anode	Anode A, B, & D.P.	Anode A	Anode B

ELECTRICAL SCHEMATIC



TYPICAL CHARACTERISTIC CURVES

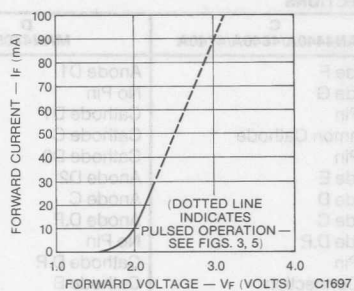


Fig. 1. Forward Current vs. Forward Voltage

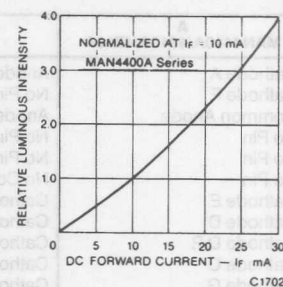


Fig. 2. Luminous Intensity vs. Forward Current

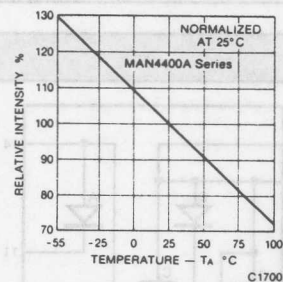


Fig. 3. Relative Luminous Intensity vs. Temperature

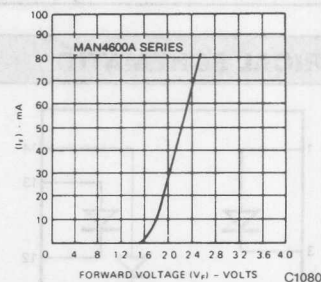


Fig. 4. Forward Current vs. Forward Voltage

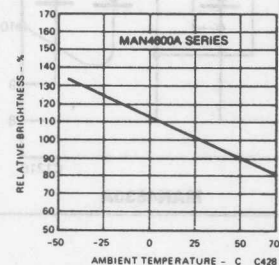


Fig. 5. Relative Luminous Intensity vs. Temperature

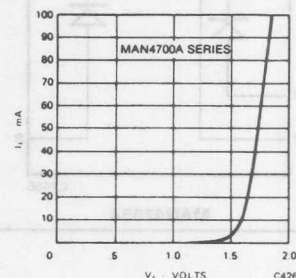


Fig. 6. Forward Current vs. Forward Voltage

TYPICAL CHARACTERISTIC CURVES (Cont'd)

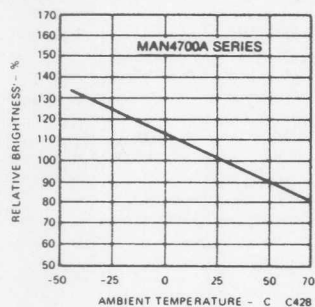


Fig. 7. Relative Luminous Intensity vs. Temperature

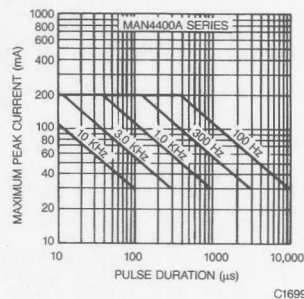


Fig. 8. Max Peak Current vs. Duty Cycle

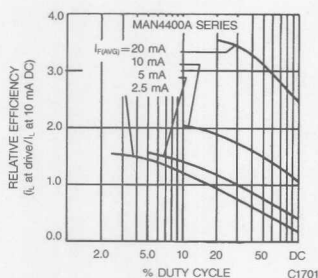


Fig. 9. Relative Luminous Intensity vs. Duty Cycle

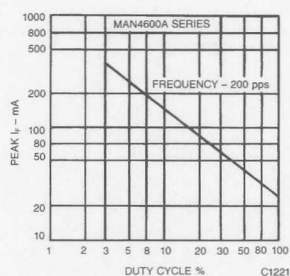


Fig. 10. Max Peak Current vs. Duty Cycle

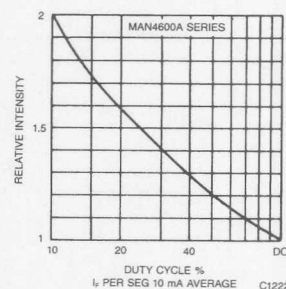


Fig. 11. Relative Luminous Intensity vs. Duty Cycle

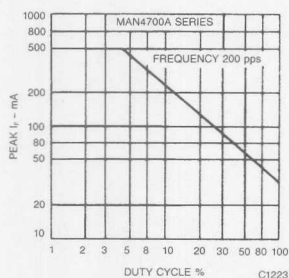


Fig. 12. Max Peak Current vs. Duty Cycle

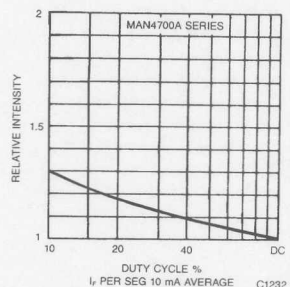


Fig. 13. Relative Luminous Intensity vs. Duty Cycle

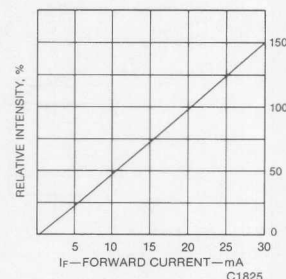
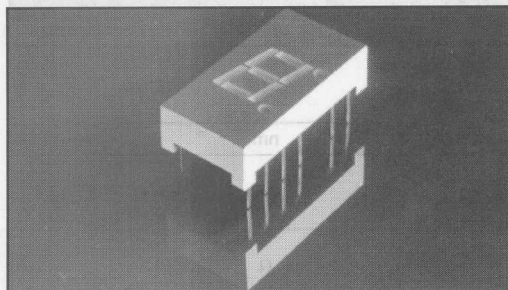


Fig. 14. Relative Luminous Intensity vs. Forward Current

HIGH EFFICIENCY RED MAN4900A SERIES



DESCRIPTION

The MAN4900A Series provides superior brightness High Efficiency Red LED display. Standard units are also available in Red, Green, and Orange. They can be mounted in arrays with 0.400-inch (10.16 mm) center-to-center spacing. Units are constructed with Red face and segment color.

FEATURES

- Common anode or common cathode models
- High Efficiency Red
- Fast switching—excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability—long operation life
- Impact resistant plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Standard dual-in-line package configuration
- Wide angle viewing . . . 150°
- Package size and lead configuration is the same as MAN3600A/70A Series
- These devices have a Red face and Red segments

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Calculators
- Digital clocks
- High ambient light conditions

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN4910A	High Efficiency Red	Common Anode; Right Hand Decimal	A	A
MAN4940A	High Efficiency Red	Common Cathode; Right Hand Decimal	A	B

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN4910A	Panelgraphic Scarlet 65
MAN4940A	Homalite 100-1670

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
MAN4910A/4940A					
Luminous Intensity, digit average (See Note 1 and 3)	450	1900		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		635		nm	
Forward voltage					
Segment		2.2	2.5	V	$I_F = 20 \text{ mA}$
Decimal point		2.2	2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient	600 mW
Derate linearly from 50°C	-8.6 mW/°C
Storage and operating temperature	-40°C to +85°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260°C (See Notes 4 and 5)	5 sec.

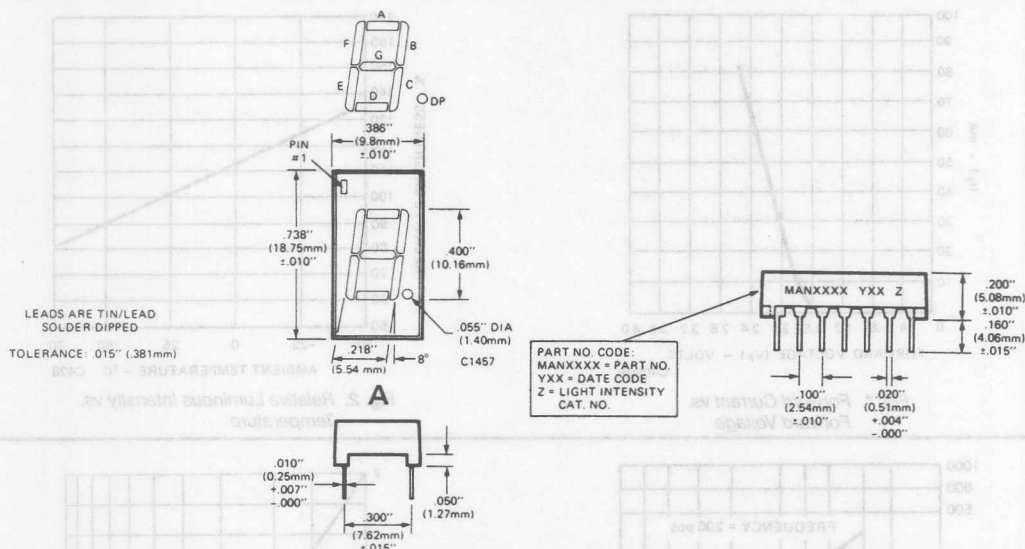
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative Luminous Intensity over the operating temperature range.
3. The decimal point is designed to have the same surface brightness as the segments, therefore, the Luminous Intensity of the decimal point is .3 times the Luminous Intensity of the segments, since the area of the decimal point is .3 times the area of the average segment.
4. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
5. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
6. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS	
	A MAN4910A	B MAN4940A
1	Cathode A	Anode F
2	Cathode F	Anode G
3	Common Anode	No Pin
4	No Pin	Common Cathode
5	No Pin	No Pin
6	No Connection	Anode E
7	Cathode E	Anode D
8	Cathode D	Anode C
9	Cathode D.P.	Anode D.P.
10	Cathode C	No Pin
11	Cathode G	No Connection
12	No Pin	Common Cathode
13	Cathode B	Anode B
14	Common Anode	Anode A

TYPICAL CHARACTERISTIC CURVES

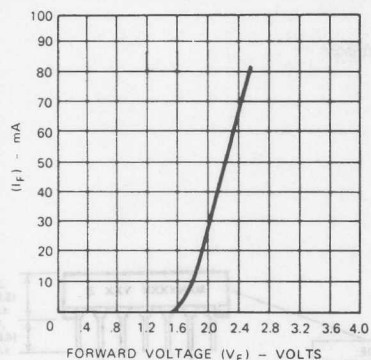


Fig. 1. Forward Current vs. Forward Voltage

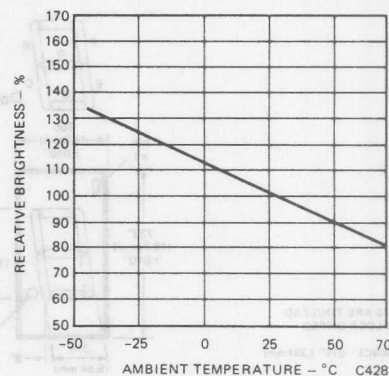


Fig. 2. Relative Luminous Intensity vs. Temperature

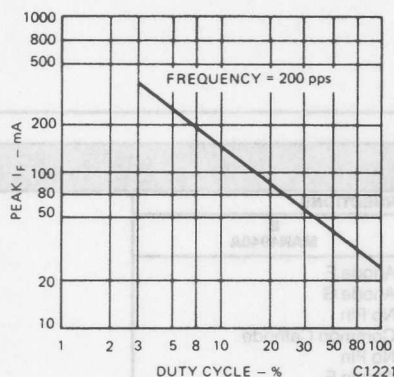


Fig. 3. Max Peak Current vs. Duty Cycle

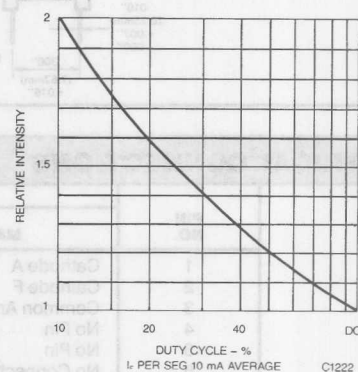


Fig. 4. Luminous Intensity vs. Duty Cycle

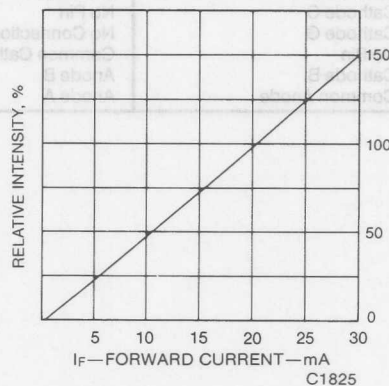
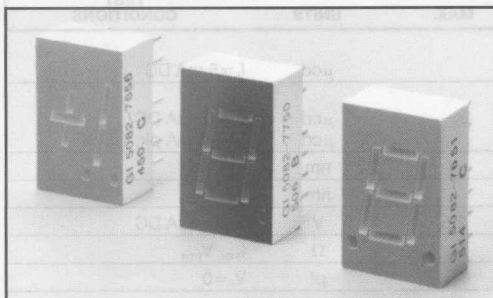


Fig. 5. Relative Luminous Intensity vs. Forward Current

**HIGH EFFICIENCY RED 5082-7650 SERIES
RED 5082-7700 SERIES**



FEATURES

- Industry-standard 0.43-inch displays
- High Efficiency Red and standard Red models
- Left or right decimal versions
- Common anode or common cathode
- Solid state reliability — long operating life
- Impact-resistant plastic construction
- Standard 14 pin DIP configuration
- Categorized for Luminous Intensity
- Wide viewing angle...150°
- Directly compatible with integrated circuits

DESCRIPTION

The 5082-7650 and 5082-7700 Series are families of High Efficiency Red and Red seven segment LED displays with 0.43-inch digit height. For maximum ON/OFF contrast, 5082-7650 Series displays have Red face and Red segment color. 5082-7700 Series have Black face and Red segment color.

APPLICATIONS

- Instrumentation
- Point of sale terminals
- Appliances
- Digital clocks
- Industrial control equipment

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION
5082-7650	High Efficiency Red	Common Anode; Left Hand Decimal
5082-7651	High Efficiency Red	Common Anode; Right Hand Decimal
5082-7653	High Efficiency Red	Common Cathode; Right Hand Decimal
5082-7656	High Efficiency Red	Universal Overflow ± 1 ; Right Hand Decimal
5082-7750	Red	Common Anode; Left Hand Decimal
5082-7751	Red	Common Anode; Right Hand Decimal
5082-7756	Red	Universal Overflow ± 1 ; Right Hand Decimal
5082-7760	Red	Common Cathode; Right Hand Decimal

RECOMMENDED OPTICAL FILTER

5082-7650 SERIES	5082-7750 SERIES
Panelgraphic Scarlet 65	Panelgraphic Red 60
Homalite 100-1670	Homalite 100-1605
Panelgraphic Gray 10	
Homalite 100-126	

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25°C Free Air Temperature Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
5082-7650 SERIES						
Luminous Intensity	I_L	340	840		μcd	$I_F=5\text{ mA DC}$
(Digit average, seven segments Notes 1, 2)			3500 1765		μcd μcd	$I_F=20\text{ mA DC}$ $I_F=60\text{ mA pk, 1:6 DF}$
Peak emission wavelength	λ_p		630		nm	
Spectral line halfwidth	$\Delta\lambda_{1/2}$		40		nm	
Forward voltage	V_F		2.0	2.5	V	$I_F=20\text{ mA DC}$
Dynamic resistance	R_d		26		Ω	I_{FTH}, V_{FTH}
Capacitance	C		35		pf	$V_F=0$
Reverse current	I_R			100	μA	$V_R=3.0\text{ V}$
Ratio I_L (max. I_L /min. I_L)	r			2.0:1		$I_F=20\text{ mA DC}$
5082-7750 SERIES						
Luminous Intensity	I_L	320	980		μcd	$I_F=20\text{ mA}$
(Digit average, seven segments Notes 1, 2)			610		μcd	$I_F=100\text{ mA Pk}$ 1:10 DF
Peak emission wavelength	λ_p		650		nm	
Spectral line halfwidth	$\Delta\lambda_{1/2}$		20		nm	
Forward voltage	V_F		1.6	2.0	V	$I_F=20\text{ mA}$
Dynamic resistance	R_d		2.0		Ω	I_{FTH}, V_{FTH}
Capacitance	C		35		pf	$V_F=0$
Reverse current	I_R			100	μA	$V_R=5.0\text{ V}$
Ratio I_L (max. I_L /min. I_L)	r			2.0:1		$I_F=20\text{ mA}$

ABSOLUTE MAXIMUM RATINGS

	HIGH EFFICIENCY RED		RED	
	5082-7650 5082-7651 5082-7653	5082-7656	5082-7750 5082-7751 5082-7760	5082-7756
Power dissipation at 50°C ambient	840 mW	630 mW	520 mW	390 mW
Derate linearly from 50°C	-16 mW/C°	-12 mW/C°	-6.9 mW/C°	-5.2 mW/C°
Storage and operating temperature	-40°C to +85°C		-40°C to +85°C	
Continuous forward current				
Total	240 mA	180 mA	200 mA	150 mA
Per segment or decimal point	30 mA	30 mA	25 mA	25 mA
Reverse voltage				
Per segment or decimal point	3 V	3 V	3 V	3 V
Soldering time at 260°C (See Notes 4 and 5.)	3 sec.	3 sec.	3 sec.	3 sec.

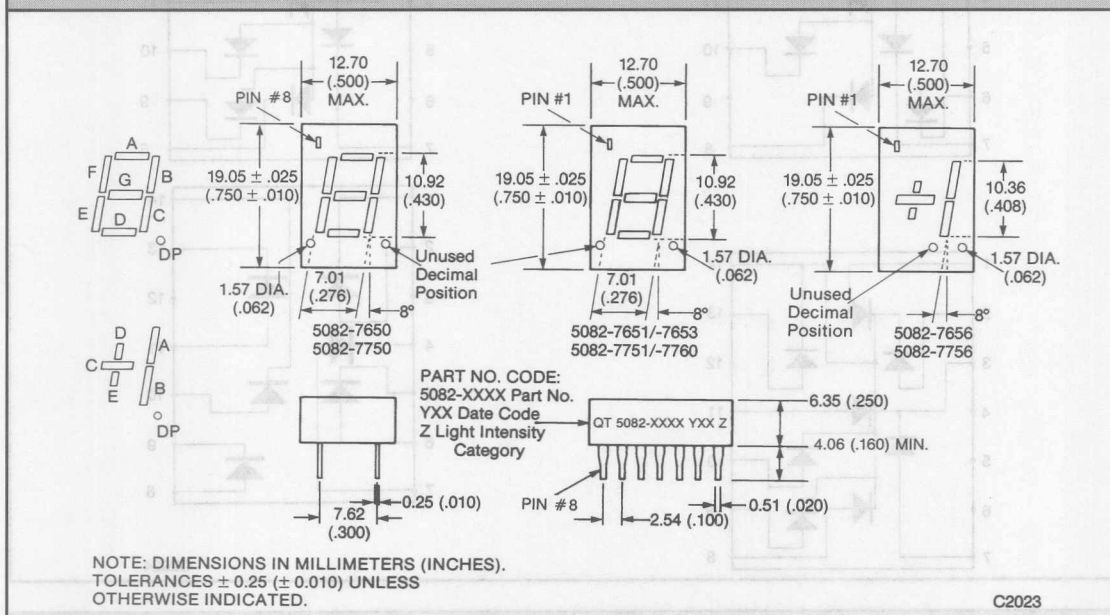
NOTES

- The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments excluding decimal points. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
- All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.
- Intensity adjusted for smaller areas of the "+" and decimal points.
- Leads immersed to 1/16 inch from the body of the device. Maximum unit surface temperature is 140°C.
- For flux removal, use Freon TF, Freon TE, Isopropanol, or water up to their boiling points.

TYPICAL THERMAL CHARACTERISTICS

	5082-765X	5082-775X	SYMBOL	TEST CONDITIONS
Thermal resistance junction to ambient	280°C/W	280°C/W	θ_{JA}	
Wavelength temperature coefficient (case temp.)	0.1 nm/°C	0.3 nm/°C	$\Delta\lambda/\lambda T$	$I_F=20\text{ mA}$
Forward voltage temperature coefficient	-2.2 mV/°C	-1.6 mV/°C	$\Delta V_F/\Delta T$	$I_F=2\text{ mA}$

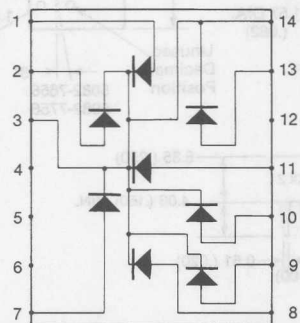
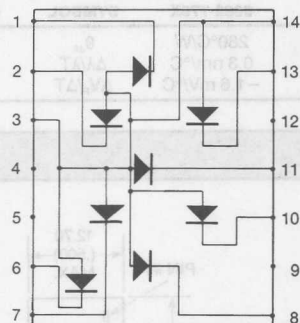
PACKAGE DIMENSIONS



CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS			
	A	B	C	D
	5082-7650/-7750	5082-7651/-7751	5082-7653/-7760	5082-7656/-7756
1	Cathode A	Cathode A	Anode A	Cathode D
2	Cathode F	Cathode F	Anode F	Anode D
3	Common Anode	Common Anode	Common Cathode	No Pin
4	No Pin	No Pin	No Pin	Cathode C
5	No Pin	No Pin	No Pin	Cathode E
6	Cathode D.P.	No Connection	No Connection	Anode E
7	Cathode E	Cathode E	Anode E	Anode C
8	Cathode D	Cathode D	Anode D	Anode D.P.
9	No Connection	Cathode D.P.	Anode D.P.	Cathode D.P.
10	Cathode C	Cathode C	Anode C	Cathode B
11	Cathode G	Cathode G	Anode G	Cathode A
12	No Pin	No Pin	No Pin	No Pin
13	Cathode B	Cathode B	Anode B	Anode A
14	Common Anode	Common Anode	Common Cathode	Anode B

ELECTRICAL SCHEMATIC



C2024

TYPICAL CURVES

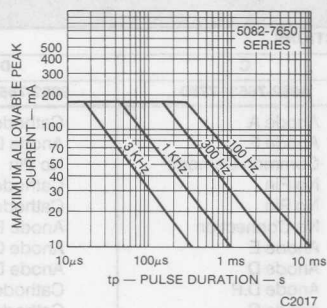


Fig. 1. Maximum Tolerable Peak Current vs. Pulse Duration

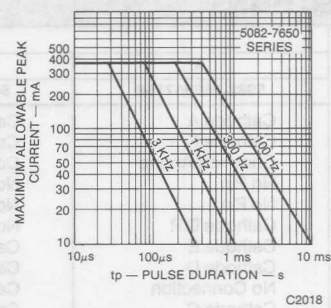


Fig. 2. Maximum Tolerable Peak Current vs. Pulse Duration

TYPICAL CHARACTERISTIC CURVES (Cont'd)

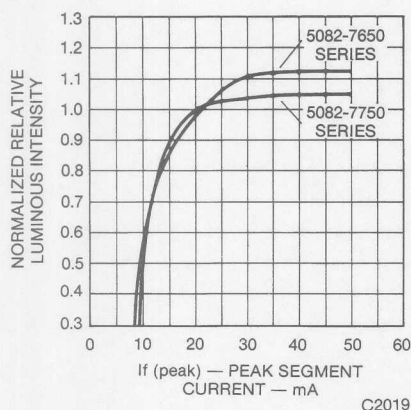


Fig. 3. Relative Efficiency
(Average Luminous
Intensity Per Unit
Current) vs. Peak
Current Per Segment

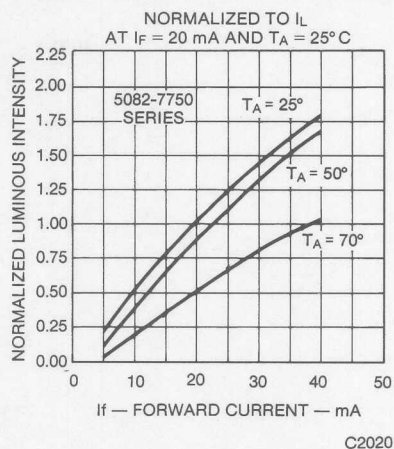


Fig. 4. Normalized Luminous
Intensity vs. Forward
Current Over
Temperature

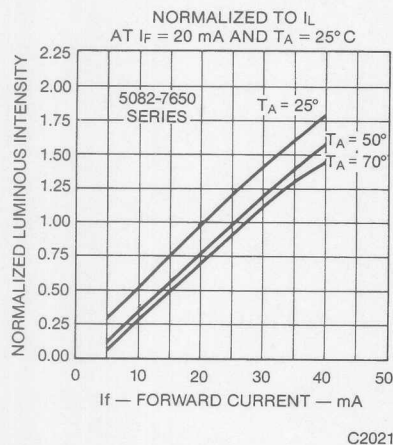


Fig. 5. Normalized Luminous
Intensity vs. Forward
Current Over
Temperature

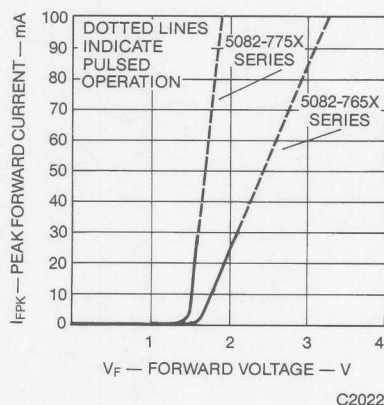
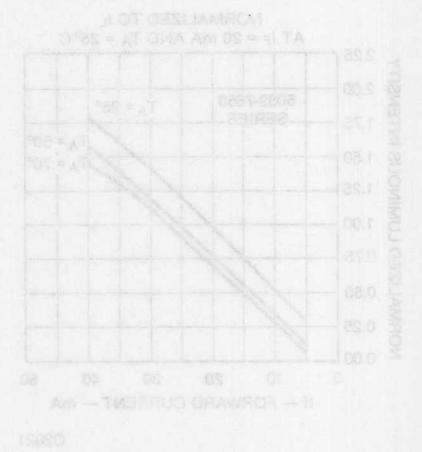
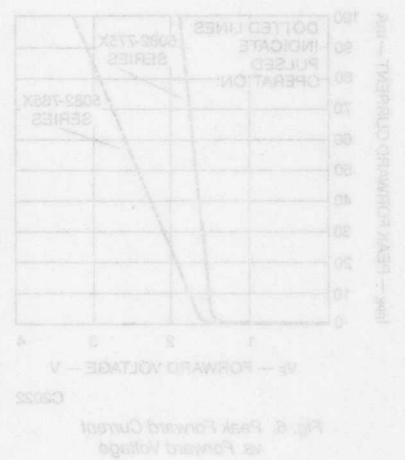
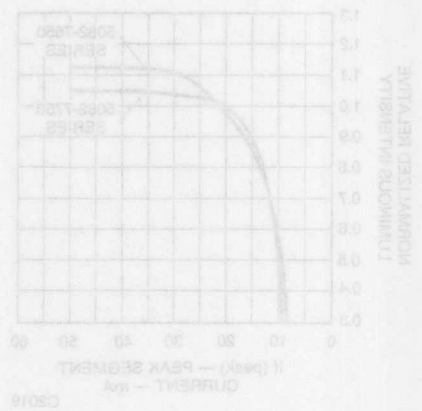
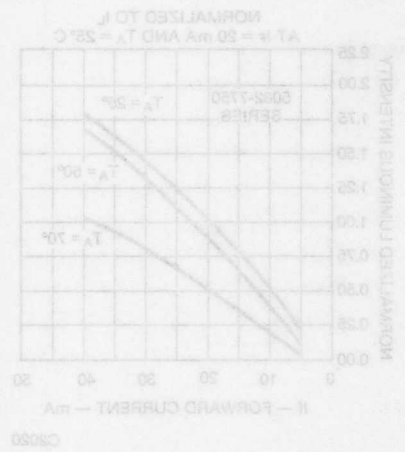


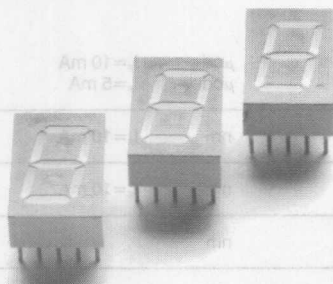
Fig. 6. Peak Forward Current
vs. Forward Voltage

TYPICAL CHARACTERISTIC CURVES



**YELLOW MAN5350/5360
GREEN MAN5450/5460**

**RED MAN5750/5760
ORANGE-RED MAN5950/5960**



FEATURES

- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching - excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability - long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for luminous intensity (see Note 5)
- Wide angle viewing . . . 150°
- Low forward voltage
- Untinted segments on grey face

DESCRIPTION

This display series is a family of large digits 0.510 inches in height. All models have right hand decimal points and are available in common anode or common cathode configurations. All units are constructed with untinted segments on grey face to enhance ON/OFF contrast. Standard units are available in red, orange-red, green and yellow.

APPLICATIONS

- For industrial and consumer applications such as:
- Digital readout displays
 - Instrument panels
 - Point of sale equipment
 - Digital clocks
 - TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PIN OUT SPECIFICATION (See Page 5)
MAN5350	Yellow	Common Anode	A
MAN5360	Yellow	Common Cathode	B
MAN5450	Green	Common Anode	A
MAN5460	Green	Common Cathode	B
MAN5750	Red	Common Anode	A
MAN5760	Red	Common Cathode	B
MAN5950	Orange-Red	Common Anode	A
MAN5960	Orange-Red	Common Cathode	B

NOTE: These devices are exact equivalents to the TELEFUNKEN Part Numbers TDSR 5150/5160, TDSO 5150/5160, TDSY 5150/5160, TDSG 5150/5160.

MAN5350/5360 MAN 5450/5460 MAN5750/5760 MAN5950/5960

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25° Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
YELLOW MAN5350/MAN5360					
Luminous Intensity, digit average (See Note 1)	820	1200 480		μcd μcd	$I_F = 10 \text{ mA}$ $I_F = 5 \text{ mA}$
Peak emission wavelength		585		nm	$I_F = 10 \text{ mA}$
Dominant wavelength	582		593	nm	$I_F = 10 \text{ mA}$
Spectral line half width		40		nm	
Forward voltage		2.4	3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance		26			$I_F = 20 \text{ mA}$
Capacitance		35		pF	$V_R = 0, f = 1 \text{ MHz}$
Reverse current			10	μA	$V_R = 6.0 \text{ V}$
GREEN MAN5450/MAN5460					
Luminous Intensity, digit average (See Note 1)	820	3000 1000		μcd μcd	$I_F = 10 \text{ mA}$ $I_F = 5 \text{ mA}$
Peak emission wavelength		562		nm	$I_F = 10 \text{ mA}$
Dominant wavelength	564		574	nm	$I_F = 10 \text{ mA}$
Spectral line half width		30		nm	
Forward voltage		2.4	3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance		12			$I_F = 20 \text{ mA}$
Capacitance		40		pF	$V_R = 0, f = 1 \text{ MHz}$
Reverse current			10	μA	$V_R = 6.0 \text{ V}$

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25° Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITION
RED MAN5750/MAN5760					
Luminous Intensity, digit average (See Note 1)	280	500 250		μcd μcd	$I_F = 10 \text{ mA}$ $I_F = 5 \text{ mA}$
Peak emission wavelength		655		nm	$I_F = 10 \text{ mA}$
Dominant wavelength		645		nm	$I_F = 10 \text{ mA}$
Spectral line half width		20		nm	
Forward voltage		1.6	2.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance		2			$I_F = 20 \text{ mA}$
Capacitance		35		pF	$V_R = 0, f = 1 \text{ MHz}$
Reverse current			10	μA	$V_R = 6.0 \text{ V}$
ORANGE-RED MAN5950/MAN5960					
Luminous Intensity, digit average (See Note 1)	820	2500 700		μcd μcd	$I_F = 10 \text{ mA}$ $I_F = 5 \text{ mA}$
Peak emission wavelength		635		nm	$I_F = 10 \text{ mA}$
Dominant wavelength	615		630	nm	$I_F = 10 \text{ mA}$
Spectral line half width		40		nm	
Forward voltage		2.0	3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance		26			$I_F = 20 \text{ mA}$
Capacitance		35		pF	$V_R = 0, f = 1 \text{ MHz}$
Reverse current			10	μA	$V_R = 6.0 \text{ V}$

ABSOLUTE MAXIMUM RATINGS

TEST CONDITION	MAN5350 MAN5360	MAN5450 MAN5460	MAN5750 MAN5760	MAN5950 MAN5960
Power Dissipation at 25°C Ambient	600 mW	570 mW	480 mW	600 mW
Derate linearly from 50°C	-10.3 mW/°C	-12 mW/°C	-6.9 mW/°C	-8.6 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current				
Total	200 mA	240 mA	240 mA	240 mA
Per segment	25 mA	30 mA	30 mA	30 mA
Decimal point	25 mA	30 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 3 and 4)	5 sec.	5 sec.	5 sec.	5 sec.

NOTES

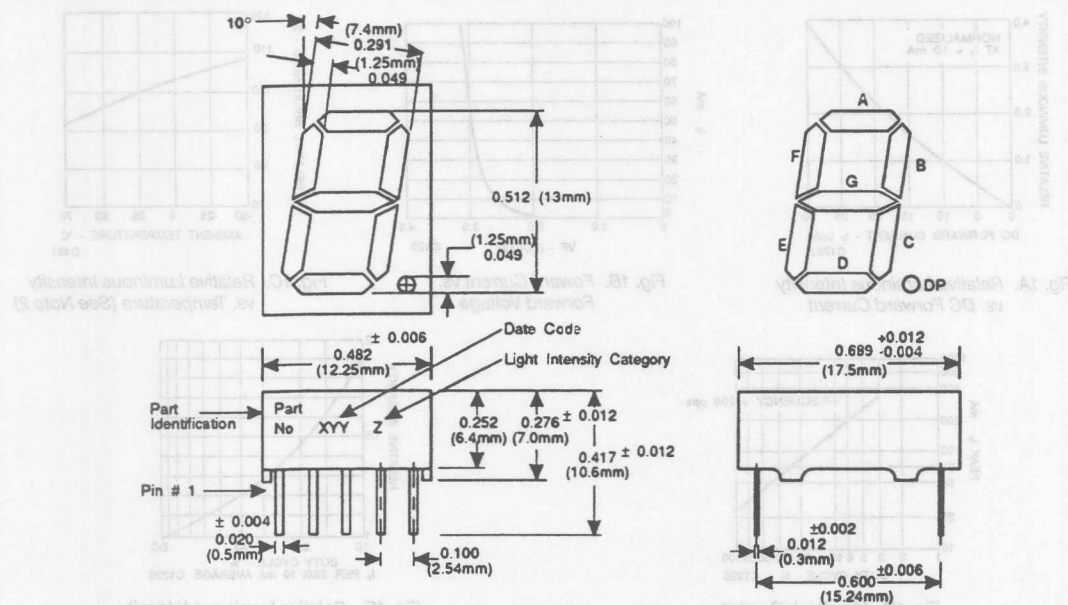
1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The relative luminous intensity in this curve is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.
3. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
5. All displays are categorized for Luminous Intensity. The intensity category is marked on each part as a suffix letter to the part number.

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER	DEVICE TYPE	FILTER
MAN5350	Panelgraphic Yellow 25 or Amber 23	MAN5450	Panelgraphic Green 48
MAN5360	Homalite 100-1720 or 100-1726	MAN5460	Homalite 100-1440 Green
	Panelgraphic Grey 10		Panelgraphic Grey 10
	Homalite 100-1266 Grey		Homalite 100-1266 Grey
MAN5750	Panelgraphic Red 60	MAN5950	Panelgraphic Scarlet 65
MAN5760	Homalite 100-1605	MAN5960	Homalite 100-1670

PACKAGE DIMENSIONS

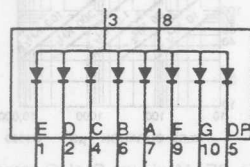


NOTE: Dimensions in inches (mm)
Tolerances ± 0.010 " unless otherwise specified

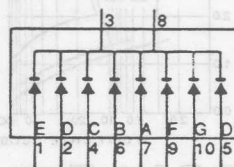
ELECTRICAL CONNECTIONS

PIN NO.	A MAN 5 X 50	B MAN 5 X 60
1	Cathode E	Anode E
2	Cathode D	Anode D
3	Com. Anode	Com. Cathode
4	Cathode C	Anode C
5	Cathode D.P.	Anode D.P.
6	Cathode B	Anode B
7	Cathode A	Anode A
8	Com. Anode	Com. Cathode
9	Cathode F	Anode F
10	Cathode G	Anode G

INTERNAL CONNECTIONS



MAN 5 X 50



MAN 5 X 60

TYPICAL CHARACTERISTIC CURVES

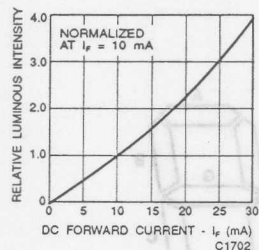


Fig. 1A. Relative Luminous Intensity vs. DC Forward Current

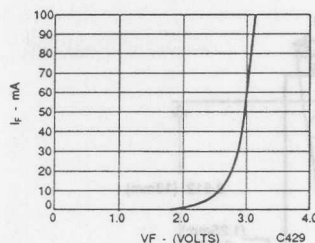


Fig. 1B. Forward Current vs. Forward Voltage

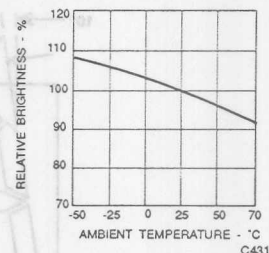


Fig. 1C. Relative Luminous Intensity vs. Temperature (See Note 2)

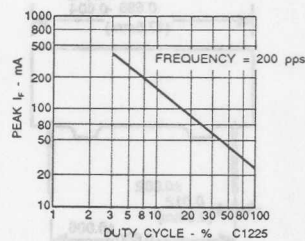


Fig. 1D. Max Peak Current vs. Duty Cycle

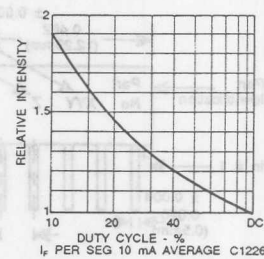


Fig. 1E. Relative Luminous Intensity vs. Duty Cycle

FIGURE 1: MAN5350/MAN5360

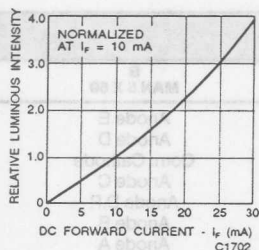


Fig. 2A. Relative Luminous Intensity vs. Forward Current

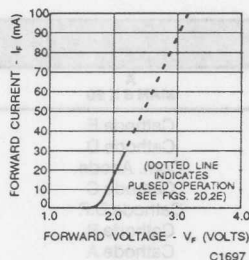


Fig. 2B. Forward Current vs. Forward Voltage

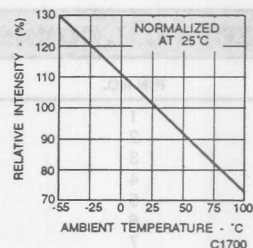


Fig. 2C. Relative Luminous Intensity vs. Temperature (See Note 2)

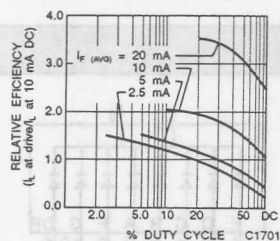


Fig. 2D. Relative Efficiency vs. Duty Cycle

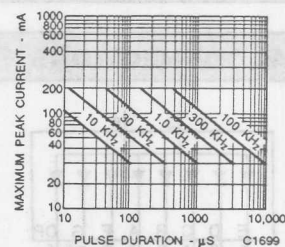


Fig. 2E. Maximum Peak Current vs. Pulse Duration

FIGURE 2: MAN5450/MAN5460

TYPICAL CHARACTERISTIC CURVES

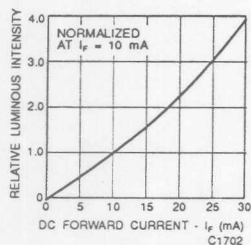


Fig. 3A. Relative Luminous Intensity vs. DC Forward Current

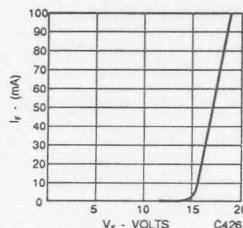


Fig. 3B. Forward Current vs. Forward Voltage

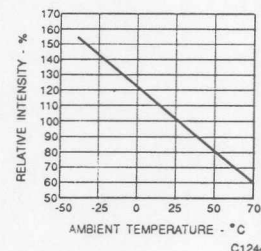


Fig. 3C. Relative Luminous Intensity vs. Temperature (See Note 2)

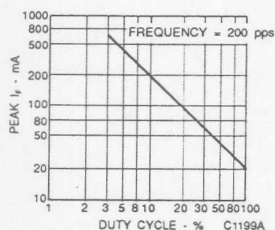


Fig. 3D. Max Peak Current vs. Duty Cycle

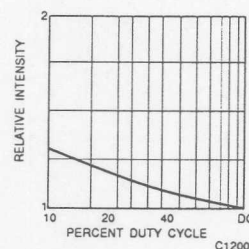


Fig. 3E. Relative Luminous Intensity vs. Duty Cycle

FIGURE 3: MAN5750/MAN5760

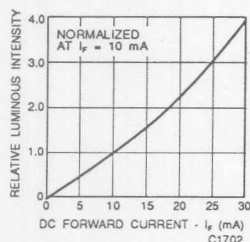


Fig. 4A. Relative Luminous Intensity vs. Forward Current

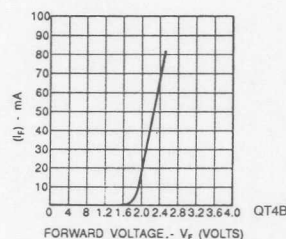


Fig. 4B. Forward Current vs. Forward Voltage

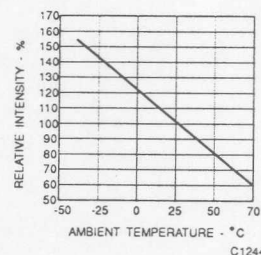


Fig. 4C. Relative Luminous Intensity vs. Temperature (See Note 2)

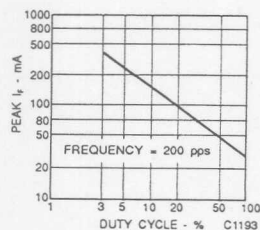


Fig. 4D. Maximum Peak Current vs. Duty Cycle

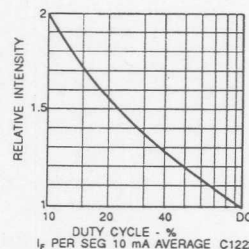
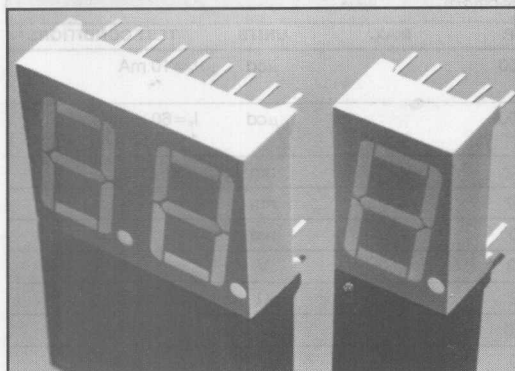


Fig. 4E. Relative Luminous Intensity vs. Duty Cycle

FIGURE 4: MAN5950/MAN5960

HIGH EFFICIENCY GREEN MAN6400 SERIES



DESCRIPTION

The MAN6400 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. All models have right hand decimal points and are available in common anode or common cathode configuration. This device has a Grey face and clear segment to enhance ON and OFF contrast.

FEATURES

- High Efficiency Green nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 5)
- Wide angle viewing...150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6410	High Eff. Green	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6440	High Eff. Green	2 Digit; Common Cathode; Rt. Hand Decimal	A	B
MAN6460	High Eff. Green	Single Digit; Common Anode; Rt. Hand Decimal	B	C
MAN6480	High Eff. Green	Single Digit; Common Cathode; Rt. Hand Decimal	B	D

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN6400 Series	Panelgraphic Green 48
	Homalite 100-1440 Green
	Panelgraphic Grey 10
	Homalite 100-1266 Grey

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Notes 1 and 4)	750	3300		μcd	I _F =10 mA
Pulsed Luminous Intensity, digit average	900	4100		μcd	I _F =60 mA peak, 1:6 DF
Peak emission wavelength		562		nm	
Dominant wavelength		567		nm	
Spectral line half width		30		nm	
Forward voltage		2.2	3.0	V	I _F =20 mA
Dynamic resistance (See Figure 1)		12		Ω	I _F =20 mA
Light rise time		500		nsec	I _F =10 mA
Capacitance		40		pF	V=0, f = 1 MHz
Reverse current			100	μA	V _R =3.0 V

ABSOLUTE MAXIMUM RATINGS

	MAN6410 MAN6440	MAN6460 MAN6480
Power dissipation at 25°C ambient	1140 mW	570 mW
Derate linearly from 50°C	-24 mW/°C	-12 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C
Continuous forward current		
Total	480 mA	240 mA
Per diode	30 mA	30 mA
Reverse voltage		
Per diode	6.0 V	6.0 V
Soldering time at 260°C (See Notes 2 and 3)	5 sec.	5 sec.

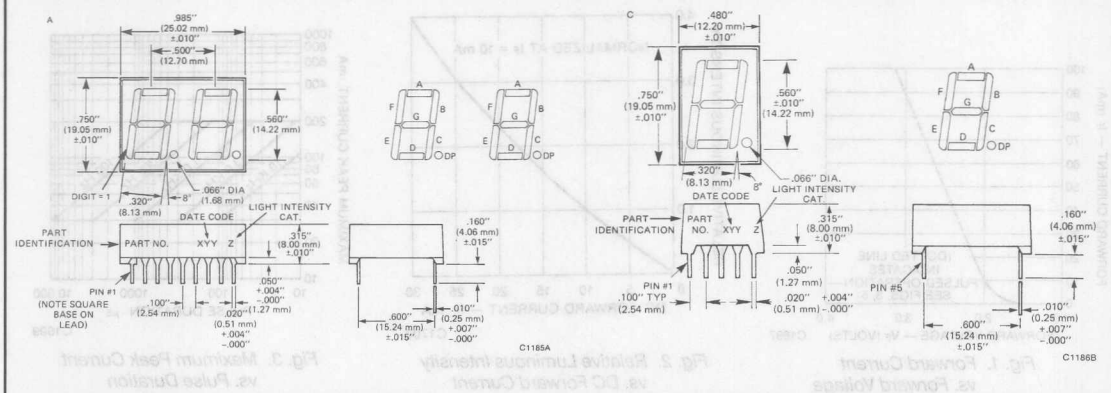
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-1.4 mV/°C

NOTES

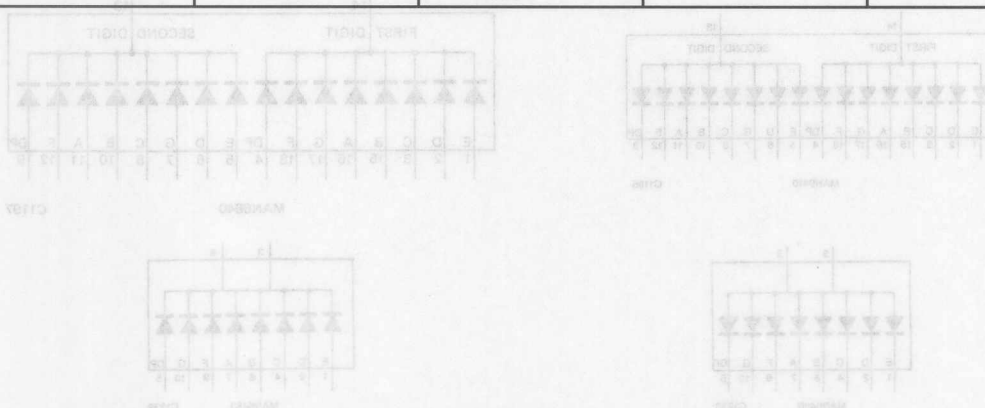
1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than ±33.3% between all segments within a digit.
2. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
3. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
4. Intensity adjusted for smaller areas of the "+" and decimal points.
5. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

Pin No.	ELECTRICAL CONNECTIONS			
	A MAN6410	B MAN6440	C MAN6460	D MAN6480
1	Cathode E 1	Anode E 1	Cathode E	Anode E
2	Cathode D 1	Anode D 1	Cathode D	Anode D
3	Cathode C 1	Anode C 1	Common Anode	Common Cathode
4	Cathode D.P. 1	Anode D.P. 1	Cathode C	Anode C
5	Cathode E 2	Anode E 2	Cathode D.P.	Anode D.P.
6	Cathode D 2	Anode D 2	Cathode B	Anode B
7	Cathode G 2	Anode G 2	Cathode A	Anode A
8	Cathode C 2	Anode C 2	Common Anode	Common Cathode
9	Cathode D.P. 2	Anode D.P. 2	Cathode F	Anode F
10	Cathode B 2	Anode B 2	Cathode G	Anode G
11	Cathode A 2	Anode A 2		
12	Cathode F 2	Anode F 2		
13	Anode Digit 2	Cathode Digit 2		
14	Anode Digit 1	Cathode Digit 1		
15	Cathode B 1	Anode B 1		
16	Cathode A 1	Anode A 1		
17	Cathode G 1	Anode G 1		
18	Cathode F 1	Anode F 1		



TYPICAL CHARACTERISTIC CURVES

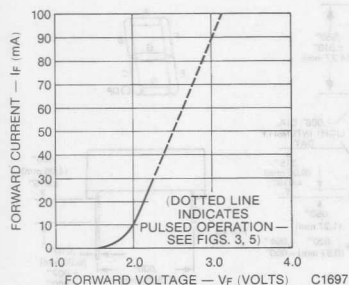


Fig. 1. Forward Current vs. Forward Voltage

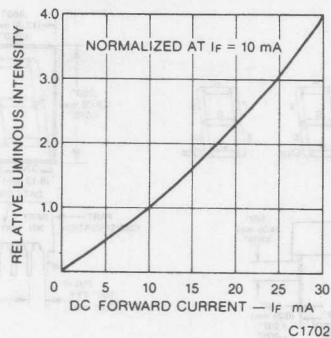


Fig. 2. Relative Luminous Intensity vs. DC Forward Current

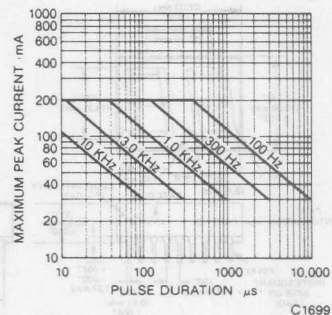


Fig. 3. Maximum Peak Current vs. Pulse Duration

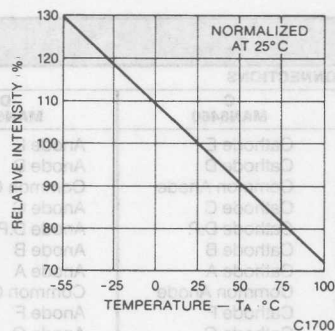


Fig. 4. Relative Luminous Intensity vs. Temperature

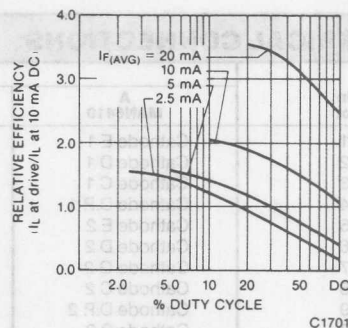
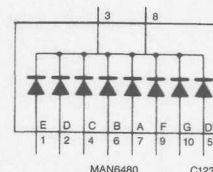
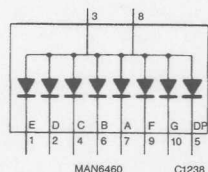
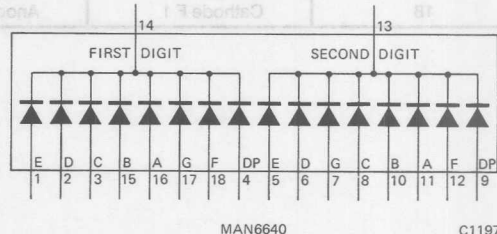
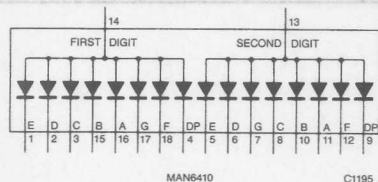
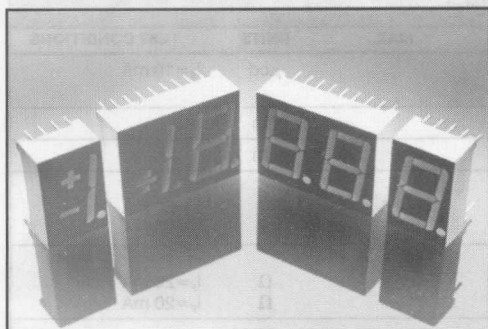


Fig. 5. Relative Efficiency vs. Duty Cycle

INTERNAL CONNECTIONS



ORANGE MAN6600 SERIES



DESCRIPTION

The MAN6600 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, single digits, and single polarity/overflow digits. All models have right hand decimal points and are available in common anode or common cathode configuration. Units are constructed with Orange face and segment color.

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide viewing angle...150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6610	Orange	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6630	Orange	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal	B	B
MAN6640	Orange	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6650	Orange	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal	B	D
MAN6660	Orange	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6675	Orange	Single Digit; Common Anode; Overflow ±1.0; Rt. Hand Decimal	D	G
MAN6680	Orange	Single Digit; Common Cathode; Rt. Hand Decimal	C	F
MAN6695	Orange	Single Digit; Common Cathode; Overflow ±1.0; Rt. Hand Decimal	D	H

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN6600 Series	Panelgraphic Scarlet 65 Homalite 100-1670

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	510	2200		μcd	I _F = 10 mA
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	I _F = 20 mA
Decimal point			2.5	V	I _F = 20 mA
Dynamic resistance					
Segment		26		Ω	I _F = 20 mA
Decimal point		26		Ω	I _F = 20 mA
Capacitance					
Segment		35		pF	V = 0
Decimal point		35		pF	V = 0
Reverse current					
Segment			100	μA	V _R = 3.0 V
Decimal point			100	μA	V _R = 3.0 V
Ratio I _L			2:1	—	I _F = 10 mA

ABSOLUTE MAXIMUM RATINGS

	MAN6610 MAN6640	MAN6630 MAN6650	MAN6660 MAN6680	MAN6675 MAN6695
Power dissipation at 25°C ambient	1200 mW	1050 mW	600 mW	375 mW
Derate linearly from 50°C	-17 mW/°C	-15.0 mW/°C	-8.6 mW/°C	-5.4 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current				
Total	480 mA	420 mA	240 mA	150 mA
Per segment	30 mA	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA	30 mA
Reverse voltage				
Per segment	6.0 V	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 3 and 4)	5 sec.	5 sec.	5 sec.	5 sec.

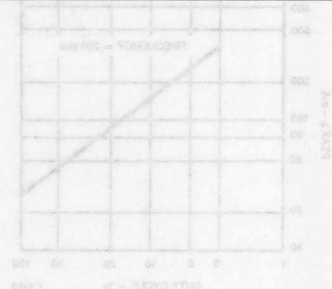
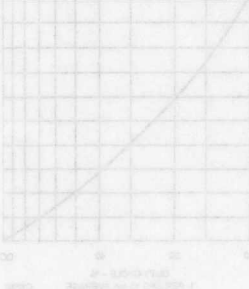
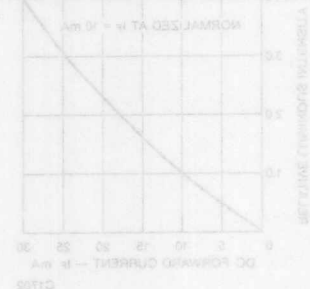
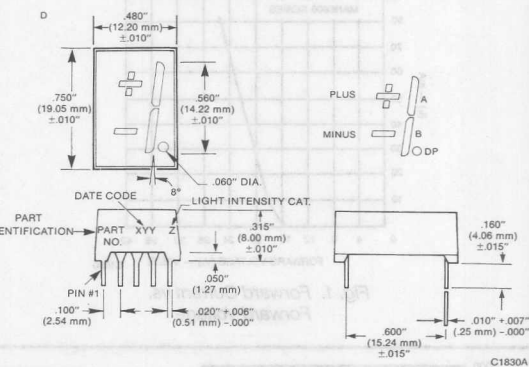
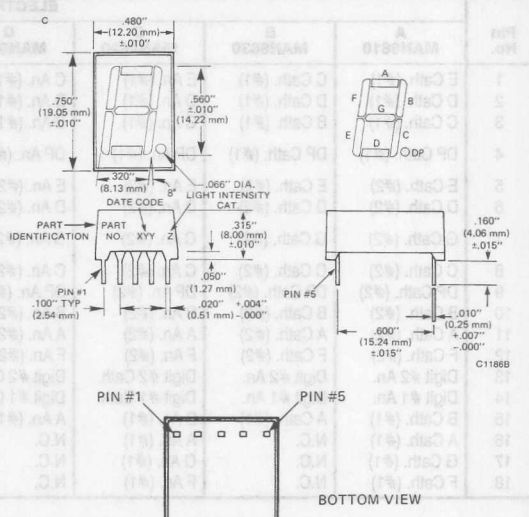
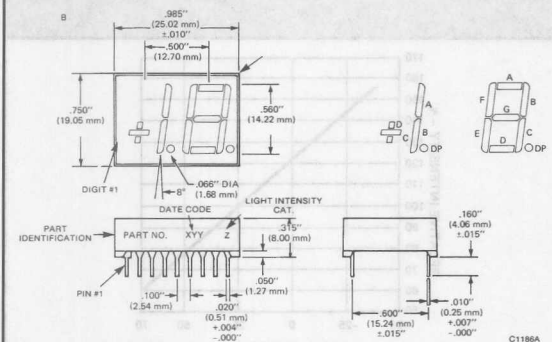
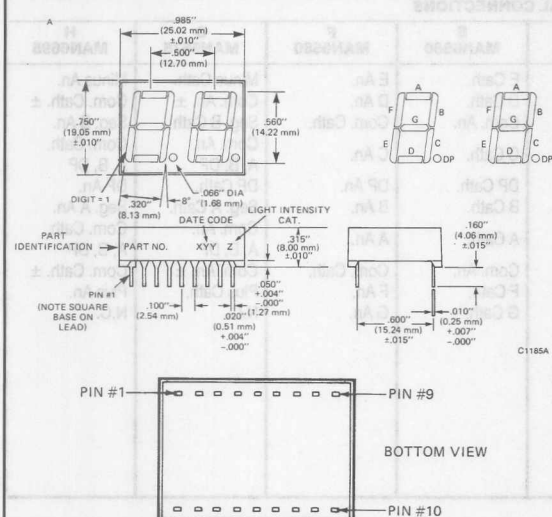
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.
3. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
5. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

Pin No.	ELECTRICAL CONNECTIONS							
	A MAN6610	B MAN6630	C MAN6640	D MAN6650	E MAN6660	F MAN6680	G MAN6675	H MAN6695
1	E Cath. (#1)	C Cath. (#1)	E An. (#1)	C An. (#1)	E Cath.	E An.	Minus Cath.	Minus An.
2	D Cath. (#1)	D Cath. (#1)	D An. (#1)	D An. (#1)	D Cath.	D An.	Com. An. $\pm$	Com. Cath. $\pm$
3	C Cath. (#1)	B Cath. (#1)	C An. (#1)	B An. (#1)	Com. An.	Com. Cath.	Seg. B Cath.	Seg. B An.
4	DP Cath. (#1)	DP Cath. (#1)	DP An. (#1)	DP An. (#1)	C Cath.	C An.	Com. An.	Com. Cath.
5	E Cath. (#2)	E Cath. (#2)	E An. (#2)	E An. (#2)	DP Cath.	DP An.	A, B, DP	A, B, DP
6	D Cath. (#2)	D Cath. (#2)	D An. (#2)	D An. (#2)	B Cath.	B An.	DP Cath.	DP An.
7	G Cath. (#2)	G Cath. (#2)	G An. (#2)	G An. (#2)	A Cath.	A An.	Seg. A Cath.	Seg. A An.
8	C Cath. (#2)	C Cath. (#2)	C An. (#2)	C An. (#2)	Com. An.	Com. Cath.	Com. An.	Com. Cath.
9	DP Cath. (#2)	DP Cath. (#2)	DP An. (#2)	DP An. (#2)	F Cath.	F An.	A, B, DP	A, B, DP
10	B Cath. (#2)	B Cath. (#2)	B An. (#2)	B An. (#2)	G Cath.	G An.	Com. An. $\pm$	Com. Cath. $\pm$
11	A Cath. (#2)	A Cath. (#2)	A An. (#2)	A An. (#2)			Plus Cath.	Plus An.
12	F Cath. (#2)	F Cath. (#2)	F An. (#2)	F An. (#2)			N.C.	N.C.
13	Digit #2 An.	Digit #2 An.	Digit #2 Cath.	Digit #2 Cath.				
14	Digit #1 An.	Digit #1 An.	Digit #1 Cath.	Digit #1 Cath.				
15	B Cath. (#1)	A Cath. (#1)	B An. (#1)	A An. (#1)				
16	A Cath. (#1)	N.C.	A An. (#1)	N.C.				
17	G Cath. (#1)	N.C.	G An. (#1)	N.C.				
18	F Cath. (#1)	N.C.	F An. (#1)	N.C.				

TYPICAL CHARACTERISTIC CURVES

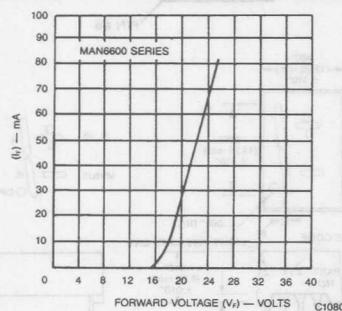


Fig. 1. Forward Current vs. Forward Voltage

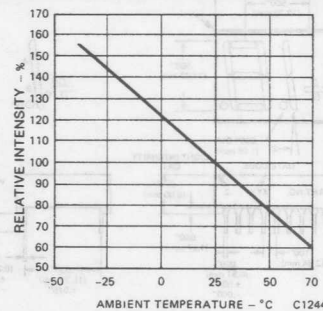


Fig. 2. Relative Luminous Intensity vs. Temperature (see Note 2)

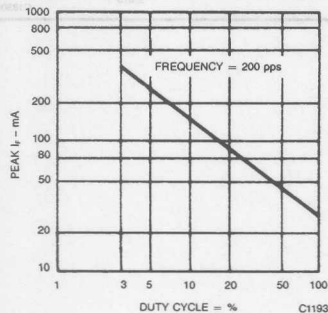


Fig. 3. Max Peak Current vs. Duty Cycle

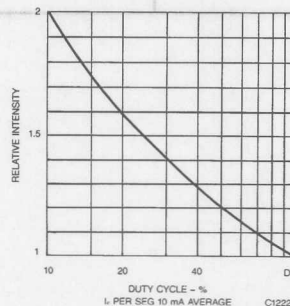


Fig. 4. Luminous Intensity vs. Duty Cycle

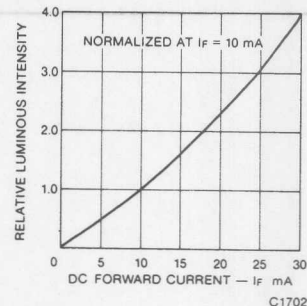
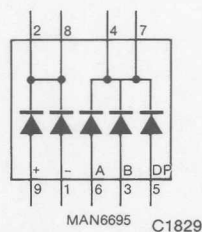
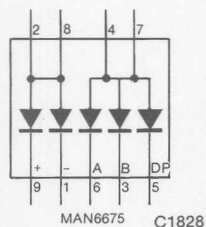
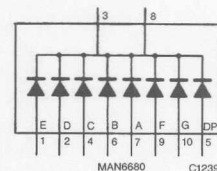
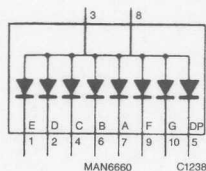
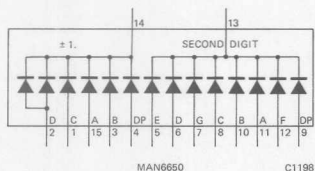
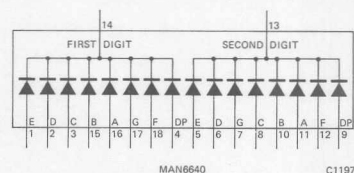
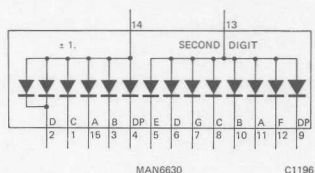
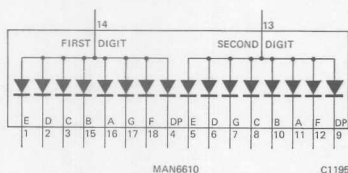
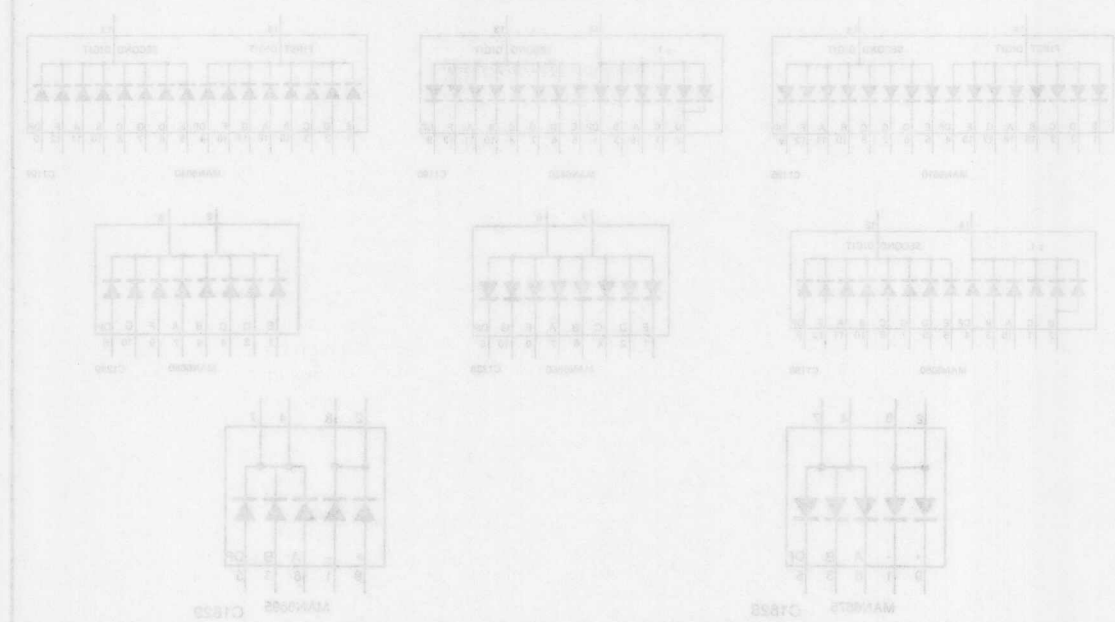


Fig. 5. Relative Luminous Intensity vs. Forward Current

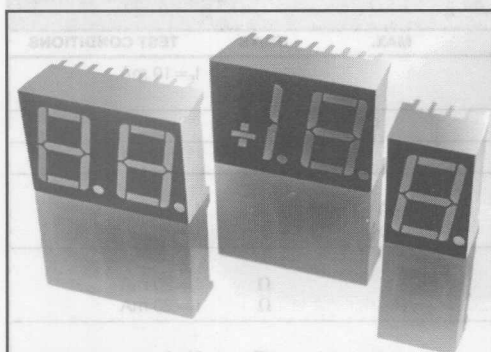
INTERNAL CONNECTIONS



INTERNAL CONNECTIONS



RED MAN6700 SERIES



DESCRIPTION

The MAN6700 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, and single digits. All models have right hand decimal points and are available in common anode or common cathode configuration. Units are constructed with Black face and Red segment color.

FEATURES

- High performance GaAsP
- Large, easy to read, digits
- Common anode or common cathode models
- Also available in Orange (MAN6600 Series)
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 7)
- Wide viewing angle...150°
- Standard double-dip lead configuration
- Low forward voltage

APPLICATIONS

For industrial and consumer applications such as:

- Two-digit package simplifies alignment and assembly
- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6710	Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6730	Red	1½ Digit; Common Anode; Overflow ±1.8; Rt. Hand Decimal	B	B
MAN6740	Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6750	Red	1½ Digit; Common Cathode; Overflow ±1.8; Rt. Hand Decimal	B	D
MAN6760	Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6780	Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN6700 Series	Panelgraphic Red 60 Homalite 100-1605

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	125	420		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		650		nm	
Spectral line half width		20		nm	
Forward voltage					
Segment			2.0	V	$I_F = 20 \text{ mA}$
Decimal point			2.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		2		Ω	$I_F = 20 \text{ mA}$
Decimal point		2		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$
Segment C or D of "+" (6730/6750)			100	μA	$V_R = 5.0 \text{ V}$

ABSOLUTE MAXIMUM RATINGS

	MAN6710 MAN6740	MAN6730 MAN6750	MAN6760 MAN6780
Power dissipation at 25°C ambient	960 mW	840 mW	480 mW
Derate linearly from 25°C	-13.7 mW/°C	-12.0 mW/°C	-6.9 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 3 and 4)	5 sec.	5 sec.	5 sec.

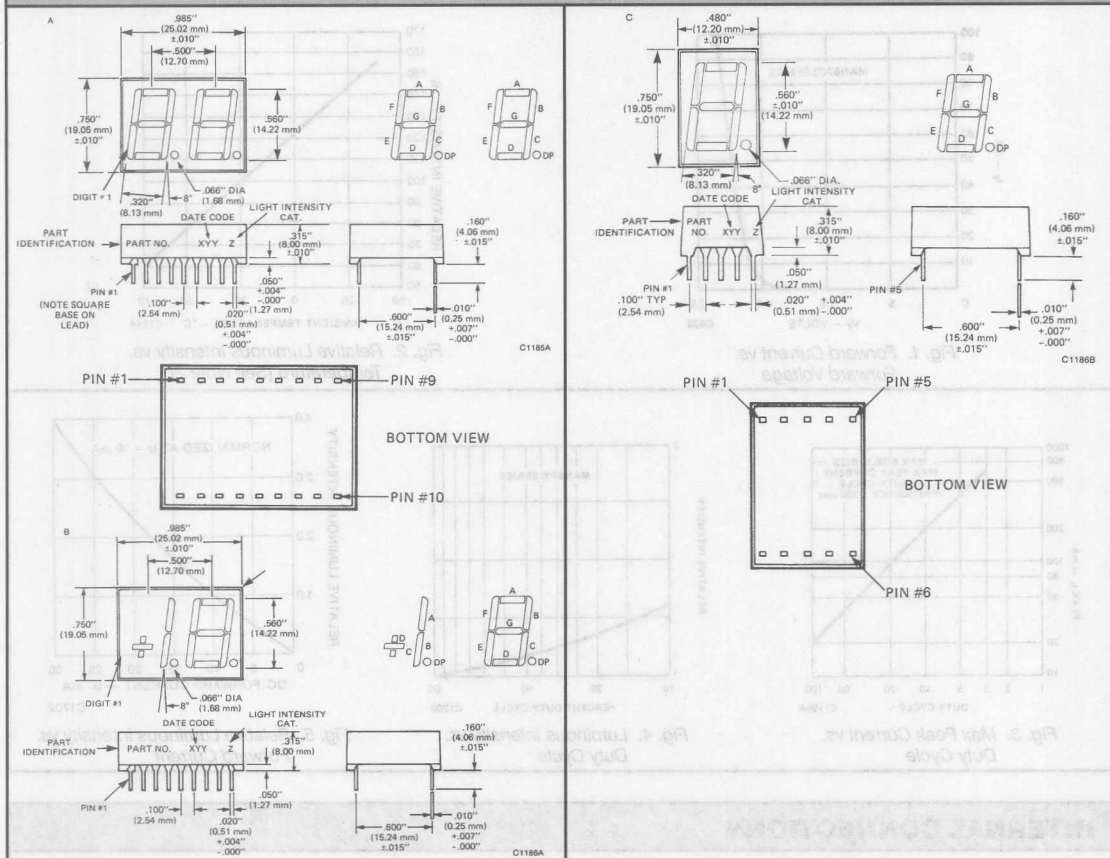
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	3.0Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.
3. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
5. Pins 3 and 8 on MAN6760 and MAN6780 are redundant anodes or cathodes.
6. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

Pin No.	ELECTRICAL CONNECTIONS					
	A MAN6710	B MAN6730	C MAN6740	D MAN6750	E MAN6760	F MAN6780
1	Cathode E 1	Cathode C 1	Anode E 1	Anode C 1	Cathode E	Anode E
2	Cathode D 1	Cathode D 1	Anode D 1	Anode D 1	Cathode D	Anode D
3	Cathode C 1	Cathode B 1	Anode C 1	Anode B 1	Com. Anode	Com. Cathode
4	Cathode D.P. 1	Cathode D.P. 1	Anode D.P. 1	Anode D.P. 1	Cathode C	Anode C
5	Cathode E 2	Cathode E 2	Anode E 2	Anode E 2	Cathode D.P.	Anode D.P.
6	Cathode D 2	Cathode D 2	Anode D 2	Anode D 2	Cathode B	Anode B
7	Cathode G 2	Cathode G 2	Anode G 2	Anode G 2	Cathode A	Anode A
8	Cathode C 2	Cathode C 2	Anode C 2	Anode C 2	Com. Anode	Com. Cathode
9	Cathode D.P. 2	Cathode D.P. 2	Anode D.P. 2	Anode D.P. 2	Cathode F	Anode F
10	Cathode B 2	Cathode B 2	Anode B 2	Anode B 2	Cathode G	Anode G
11	Cathode A 2	Cathode A 2	Anode A 2	Anode A 2		
12	Cathode F 2	Cathode F 2	Anode F 2	Anode F 2		
13	Anode Digit 2	Anode Digit 2	Cathode Digit 2	Cathode Digit 2		
14	Anode Digit 1	Anode Digit 1	Cathode Digit 1	Cathode Digit 1		
15	Cathode B 1	Cathode A 1	Anode B 1	Anode A 1		
16	Cathode A 1	No Connection	Anode A 1	No Connection		
17	Cathode G 1	No Connection	Anode G 1	No Connection		
18	Cathode F 1	No Connection	Anode F 1	No Connection		

TYPICAL CHARACTERISTIC CURVES

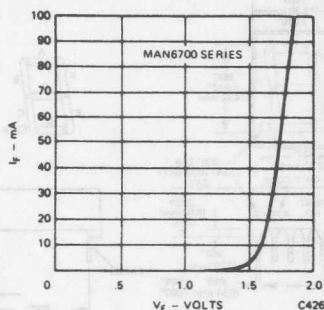


Fig. 1. Forward Current vs. Forward Voltage

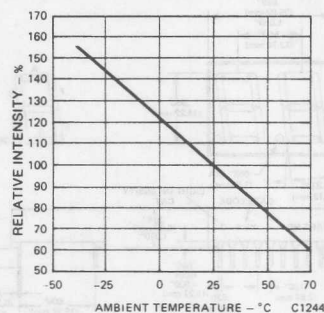


Fig. 2. Relative Luminous Intensity vs. Temperature (See Note 2)

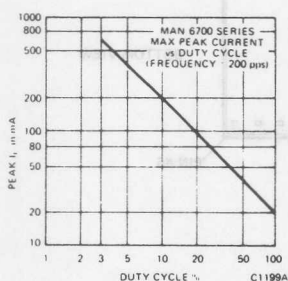


Fig. 3. Max Peak Current vs. Duty Cycle

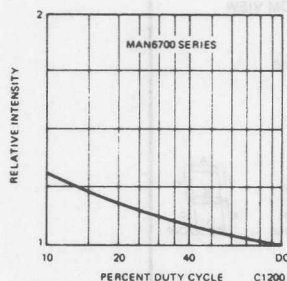


Fig. 4. Luminous Intensity vs. Duty Cycle

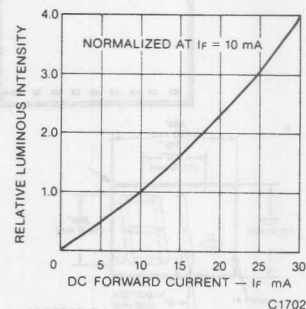
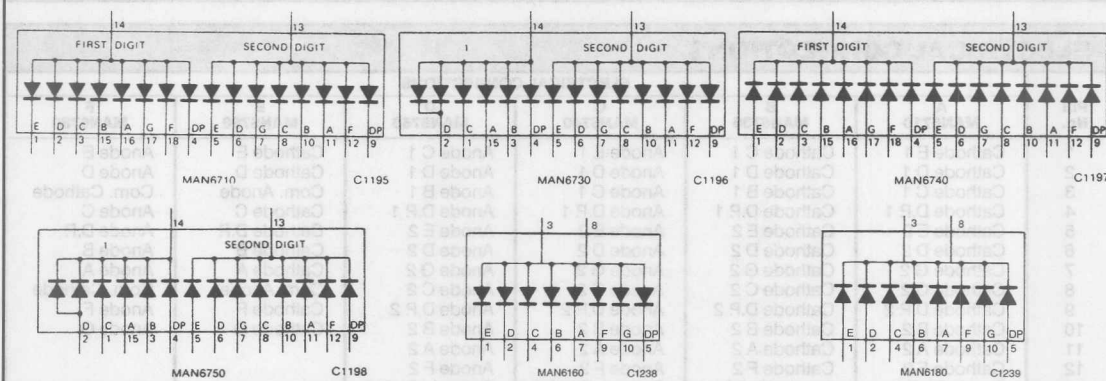
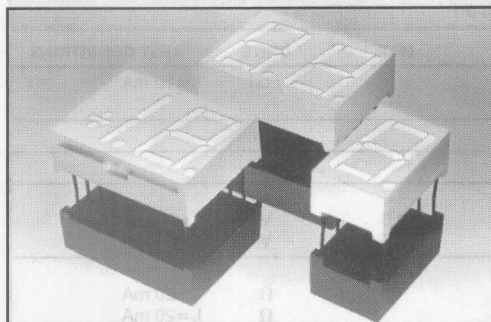


Fig. 5. Relative Luminous Intensity vs. Forward Current

INTERNAL CONNECTIONS



HIGH EFFICIENCY RED MAN6900 SERIES



DESCRIPTION

The MAN6900 Series is a family of large digits which includes double and single digits. The series features the sculptured font which minimizes "gappiness" at the segment intersections. Available models include two-digit, one and one-half digits with polarity sign, and single digits. All models have right hand decimal points and are available in common anode or common cathode configuration. This device has a Red face and Red segments.

FEATURES

- High Efficiency Red nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing...150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING	PIN OUT SPECIFICATION
MAN6910	High Eff. Red	2 Digit; Common Anode; Rt. Hand Decimal	A	A
MAN6930	High Eff. Red	1 1/2 Digit; Common Anode; Overflow ± 1.8 ; Rt. Hand Decimal	B	B
MAN6940	High Eff. Red	2 Digit; Common Cathode; Rt. Hand Decimal	A	C
MAN6950	High Eff. Red	1 1/2 Digit; Common Cathode; Overflow ± 1.8 ; Rt. Hand Decimal	B	D
MAN6960	High Eff. Red	Single Digit; Common Anode; Rt. Hand Decimal	C	E
MAN6980	High Eff. Red	Single Digit; Common Cathode; Rt. Hand Decimal	C	F

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN6900 Series	Panelgraphic Scarlet 65 Homalite 100-1670

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	510	2200		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20 \text{ mA}$
Decimal point			2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 5.0 \text{ V}$
Decimal point			100	μA	$V_R = 5.0 \text{ V}$

ABSOLUTE MAXIMUM RATINGS

	MAN6910 MAN6940	MAN6930 MAN6950	MAN6960 MAN6980
Power dissipation at 25°C ambient	1200 mW	1050 mW	600 mW
Derate linearly from 50°C	-17.1 mW/°C	-15.0 mW/°C	-8.6 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	480 mA	420 mA	240 mA
Per segment	30 mA	30 mA	30 mA
Decimal point	30 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Decimal point	6.0 V	6.0 V	6.0 V
Soldering time at 260°C (See Notes 3 and 4)	5 sec.	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.
3. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
5. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

PACKAGE DIMENSIONS

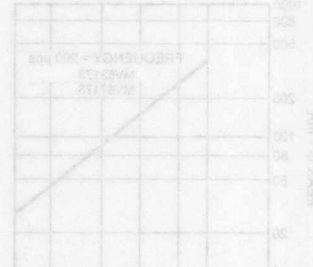
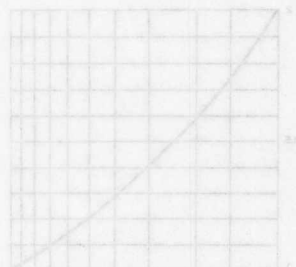
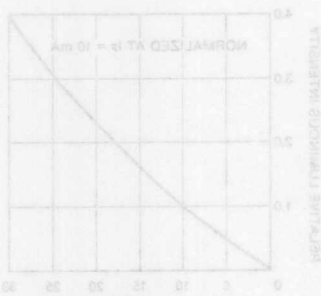
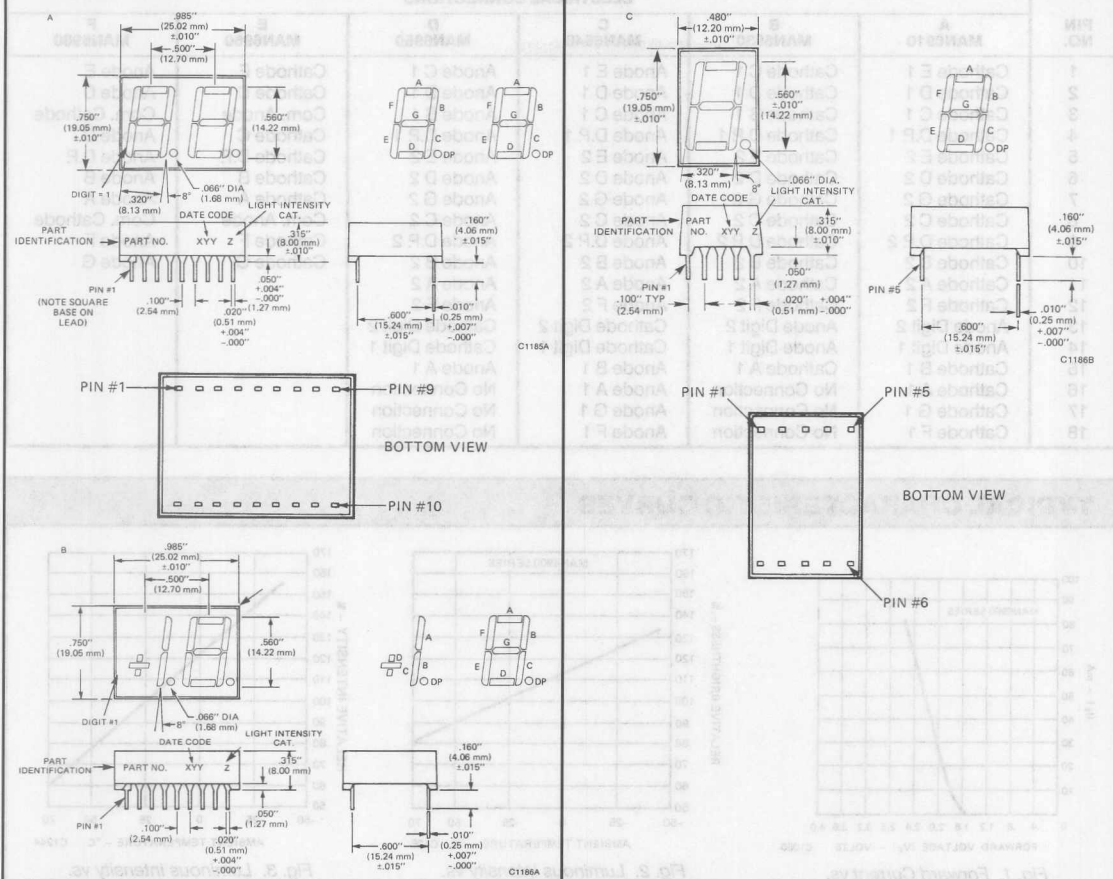


Fig. 1. Normalized AT vs DC Forward Current

Fig. 2. Relative Luminous Intensity vs Duty Cycle

Fig. 3. Max Peak Current vs Duty Cycle

ELECTRICAL CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS					
	A MAN6910	B MAN6930	C MAN6940	D MAN6950	E MAN6960	F MAN6980
1	Cathode E 1	Cathode C 1	Anode E 1	Anode C 1	Cathode E	Anode E
2	Cathode D 1	Cathode D 1	Anode D 1	Anode D 1	Cathode D	Anode D
3	Cathode C 1	Cathode B 1	Anode C 1	Anode B 1	Com. Anode	Com. Cathode
4	Cathode D.P. 1	Cathode D.P. 1	Anode D.P. 1	Anode D.P. 1	Cathode C	Anode C
5	Cathode E 2	Cathode E 2	Anode E 2	Anode E 2	Cathode D.P.	Anode D.P.
6	Cathode D 2	Cathode D 2	Anode D 2	Anode D 2	Cathode B	Anode B
7	Cathode G 2	Cathode G 2	Anode G 2	Anode G 2	Cathode A	Anode A
8	Cathode C 2	Cathode C 2	Anode C 2	Anode C 2	Com. Anode	Com. Cathode
9	Cathode D.P. 2	Cathode D.P. 2	Anode D.P. 2	Anode D.P. 2	Cathode F	Anode F
10	Cathode B 2	Cathode B 2	Anode B 2	Anode B 2	Cathode G	Anode G
11	Cathode A 2	Cathode A 2	Anode A 2	Anode A 2		
12	Cathode F 2	Cathode F 2	Anode F 2	Anode F 2		
13	Anode Digit 2	Anode Digit 2	Cathode Digit 2	Cathode Digit 2		
14	Anode Digit 1	Anode Digit 1	Cathode Digit 1	Cathode Digit 1		
15	Cathode B 1	Cathode A 1	Anode B 1	Anode A 1		
16	Cathode A 1	No Connection	Anode A 1	No Connection		
17	Cathode G 1	No Connection	Anode G 1	No Connection		
18	Cathode F 1	No Connection	Anode F 1	No Connection		

TYPICAL CHARACTERISTIC CURVES

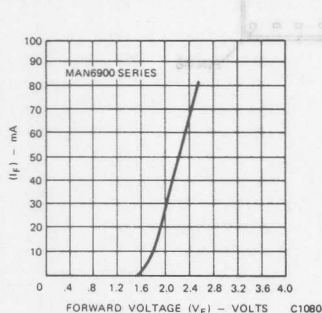


Fig. 1. Forward Current vs. Forward Voltage

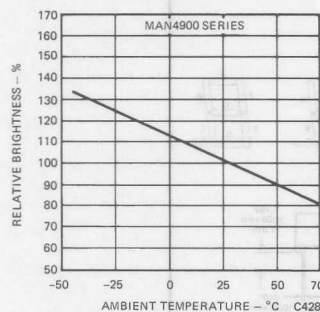


Fig. 2. Luminous Intensity vs. Forward Current

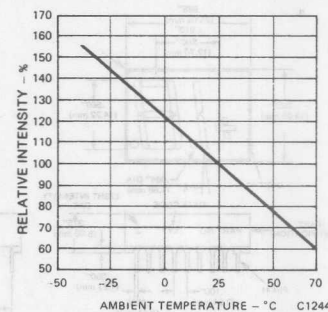


Fig. 3. Luminous Intensity vs. Temperature (See Note 2)

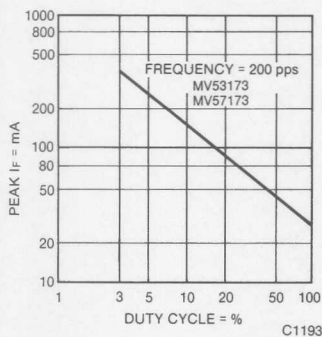


Fig. 4. Max Peak Current vs. Duty Cycle

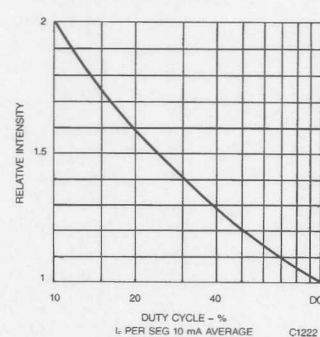


Fig. 5. Luminous Intensity vs. Duty Cycle

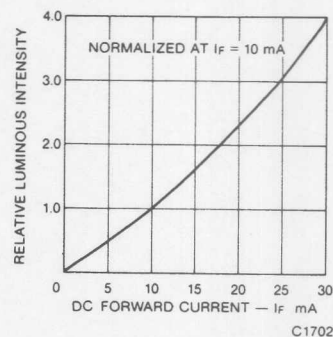
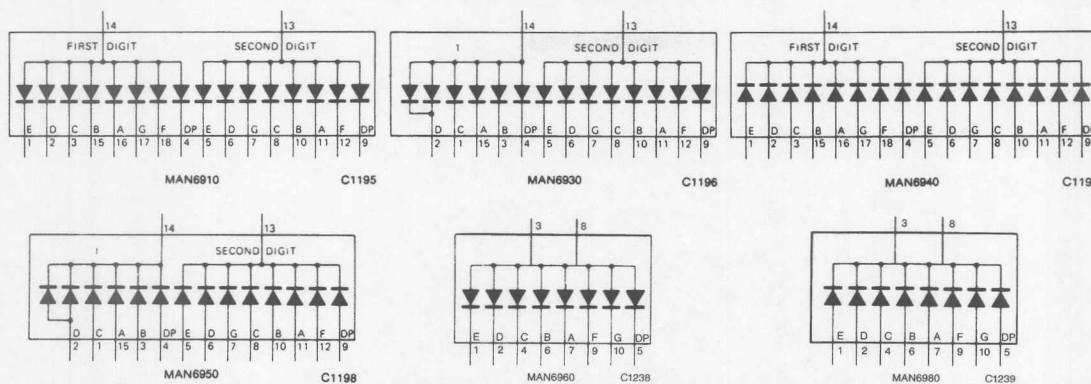
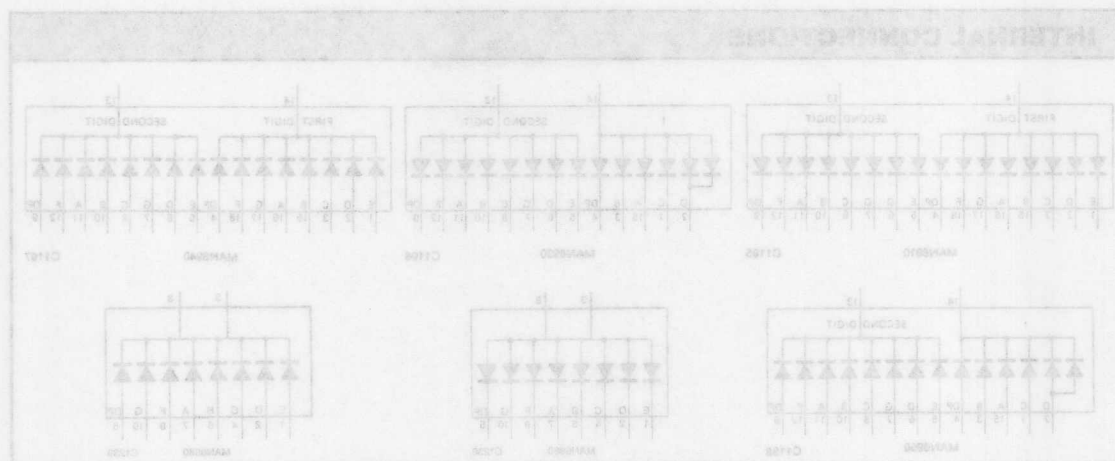


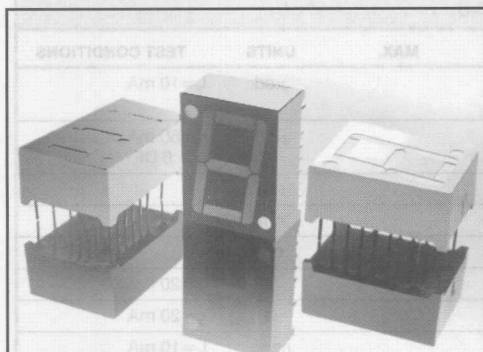
Fig. 6. Relative Luminous Intensity vs. Forward Current

INTERNAL CONNECTIONS





HIGH EFFICIENCY GREEN MAN8400 SERIES



DESCRIPTION

The MAN8400 Series is a family of large digits 0.8-inches in height. This series combines high brightness, large size, good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points. The display ON and OFF contrast has been optimized for high ambient light conditions by use of a neutral Grey face and diffused White segments. Construction makes use of a metal leadframe, plastic reflector cap with epoxy-filled segments and back.

FEATURES

- High Efficiency Green nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 5)
- Wide angle viewing ... 150°
- Low forward voltage
- Two-digit package simplifies alignment and assembly

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8410	High Efficiency Green	Common Anode; Right Hand Decimal	1
MAN8440	High Efficiency Green	Common Cathode; Right Hand Decimal	1

RECOMMENDED OPTICAL FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

DEVICE TYPE	FILTER
MAN8400 Series	Panelgraphic Green 48
	Homalite 100-1440 Green
	Panelgraphic Grey 10
	Homalite 100-1266 Grey

ELECTRO-OPTICAL CHARACTERISTICS

(Per Diode at 25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Notes 1 and 4)	750	3200		μcd	$I_F = 10 \text{ mA}$
Pulsed Luminous Intensity, digit average	900	4000		μcd	$I_F = 60 \text{ mA peak}$ 1:6 DF
Peak emission wavelength		562		nm	
Dominant wavelength		567		nm	
Spectral line half width		30		nm	
Forward voltage	2.2		3.0	V	$I_F = 20 \text{ mA}$
Dynamic resistance (See Figure 1)		12		Ω	$I_F = 20 \text{ mA}$
Light rise time		500		nsec	$I_F = 10 \text{ mA}$
Capacitance		40		pF	$V = 0, f = \text{MHz}$
Reverse current			100	μA	$V_R = 3.0 \text{ V}$

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient	600 mW
Derate linearly from 50°C	-12 mW/°C
Storage and operating temperature	-40°C to +85°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260°C (See Notes 2 and 3)	5 sec.

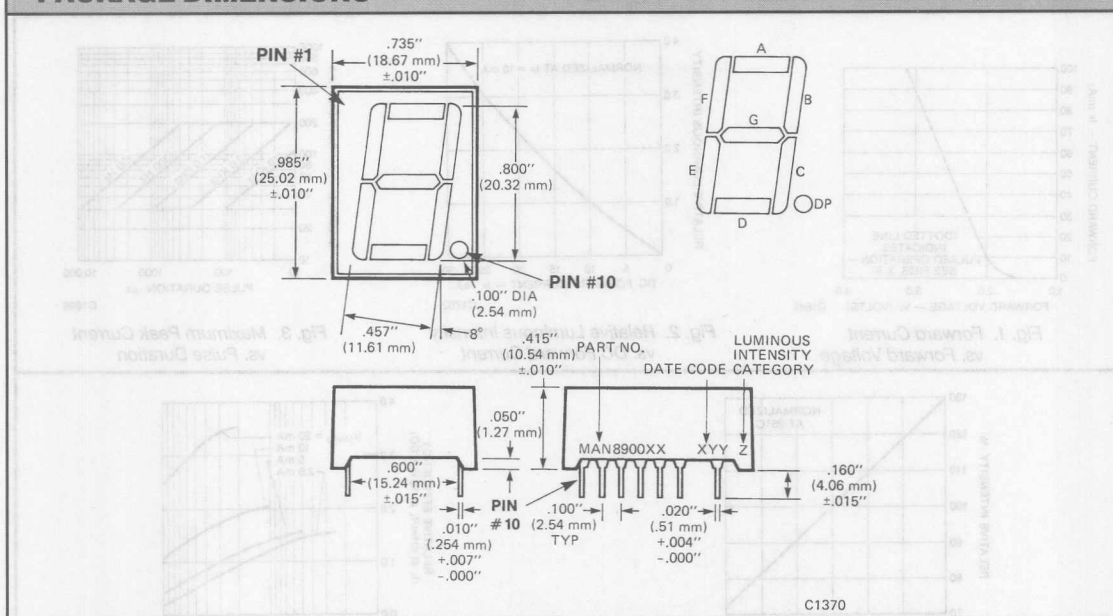
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air θ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-1.4 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
3. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
4. Intensity adjusted for smaller areas of the "+" and decimal points.
5. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

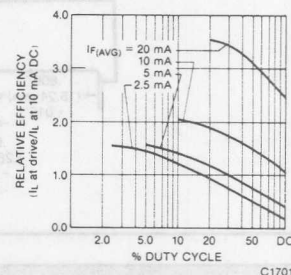
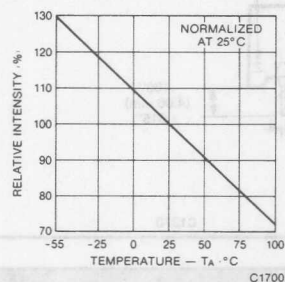
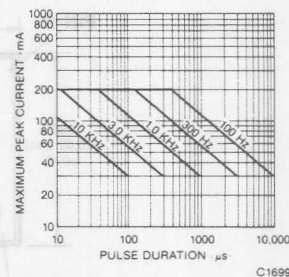
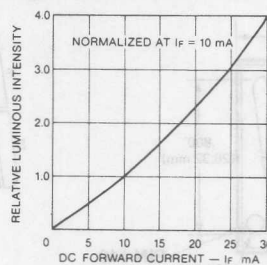
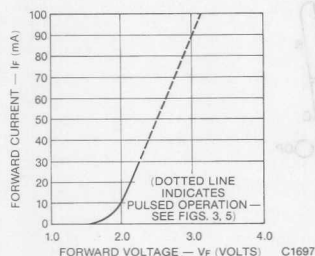
PACKAGE DIMENSIONS



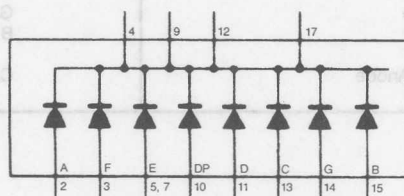
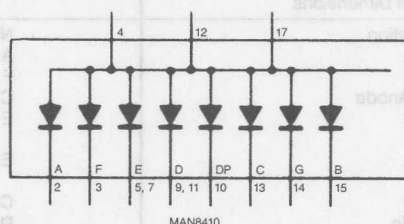
ELECTRICAL CONNECTIONS

ELECTRICAL CONNECTIONS		
PIN #	MAN8410	MAN8440
	Digit	Digit
Package Dimensions	Common Anode	Common Cathode
	Package Dimensions	Package Dimensions
1	No Connection	No Connection
2	A Cathode	A Anode
3	F Cathode	F Anode
4	Common Anode	Common Cathode
5	E Cathode	E Anode
6	—	—
7	E Cathode	E Anode
8	—	—
9	D Cathode	Common Cathode
10	DP Cathode	DP Anode
11	D Cathode	D Anode
12	Common Anode	Common Cathode
13	C Cathode	C Anode
14	G Cathode	G Anode
15	B Cathode	B Anode
16	—	—
17	Common Anode	Common Anode
18	—	—

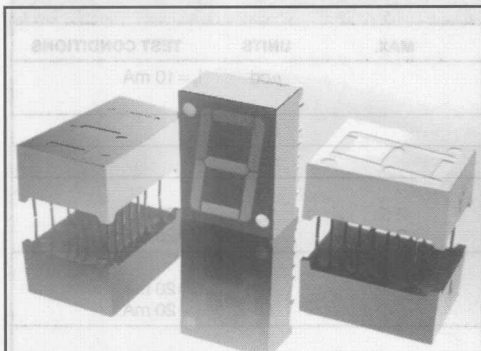
TYPICAL CHARACTERISTIC CURVES



INTERNAL CONNECTIONS



HIGH EFFICIENCY RED (ORANGE) MAN8600 SERIES



DESCRIPTION

The MAN8600 Series is a family of large digits 0.8-inches in height. This series combines high brightness, large size, good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points. Units are constructed with Grey face and neutral segment color.

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing... 150°
- Low forward voltage
- Grey face for use in high ambient light conditions

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8610	High Efficiency Red (Orange)	Common Anode; Right Hand Decimal	1
MAN8640	High Efficiency Red (Orange)	Common Cathode; Right Hand Decimal	1

RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

Panelgraphic Scarlet 65
Homalite 100-1670

In situations of high ambient light, contrast with the Grey face can be enhanced by using a neutral density filter. The following or an equivalent can be used:

Panelgraphic Grey 10

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	600	2200		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		630		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20 \text{ mA}$
Decimal point			2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance				Ω	$I_F = 20 \text{ mA}$
Segment		26			
Decimal point		26			$I_F = 20 \text{ mA}$
Capacitance				pF	$V = 0$
Segment		35			
Decimal point		35		pF	$V = 0$
Reverse current				μA	$V_R = 3.0 \text{ V}$
Segment			100		
Decimal point			100	μA	$V_R = 3.0 \text{ V}$
Luminous Intensity Ratio I_L (segment-to-segment)			2:1	—	$I_F = 10 \text{ mA}$

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient	600 mW
Derate linearly from 50°C	-8.6 mW/°C
Storage and operating temperature	-40°C to +85°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260°C (See Note 4)	5 sec.
Peak forward current per segment (I_{max}) (See Figure 4)	—

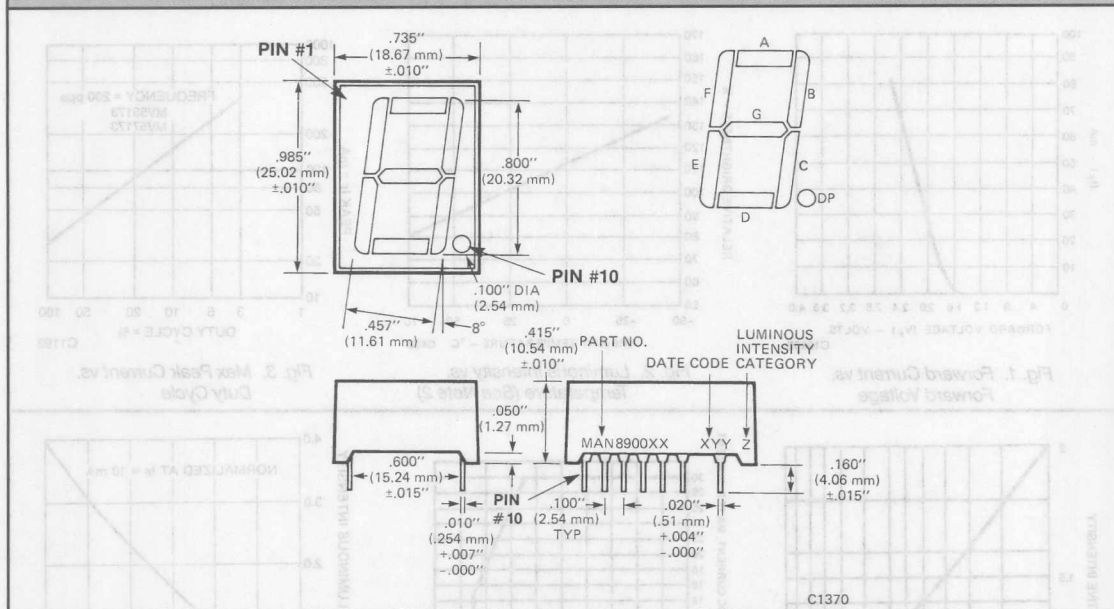
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	-2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.
3. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
5. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

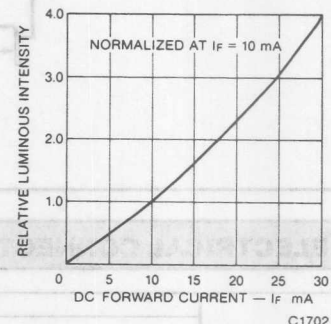
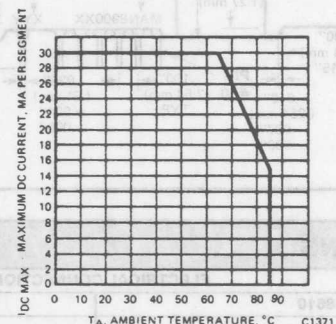
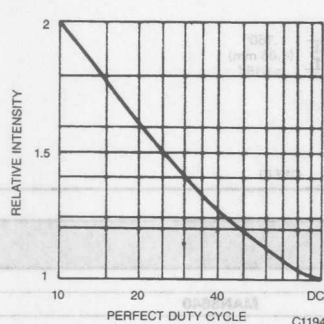
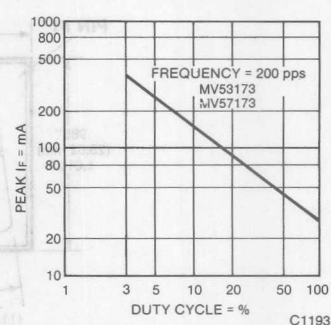
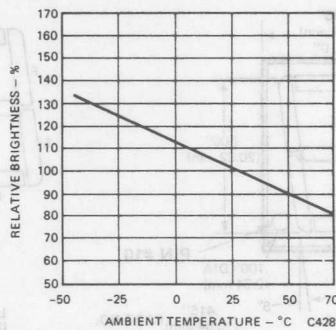
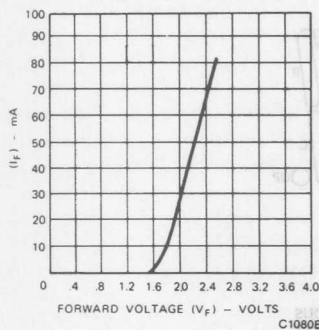
PACKAGE DIMENSIONS



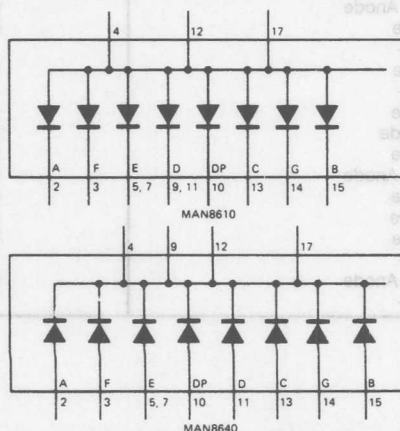
ELECTRICAL CONNECTIONS

ELECTRICAL CONNECTIONS		
MAN8610		MAN8640
Digit		Digit
Common Anode		Common Cathode
PIN #	Package Dimensions	Package Dimensions
1	No Connection	No Connection
2	A Cathode	A Anode
3	F Cathode	F Anode
4	Common Anode	Common Cathode
5	E Cathode	E Anode
6	—	—
7	E Cathode	E Anode
8	—	—
9	D Cathode	Common Cathode
10	DP Cathode	DP Anode
11	D Cathode	D Anode
12	Common Anode	Common Cathode
13	C Cathode	C Anode
14	G Cathode	G Anode
15	B Cathode	B Anode
16	—	—
17	Common Anode	Common Cathode
18	—	—

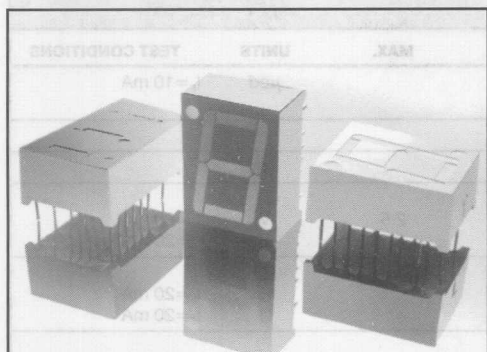
TYPICAL CHARACTERISTIC CURVES



INTERNAL CONNECTIONS



HIGH EFFICIENCY RED MAN8900 SERIES



DESCRIPTION

The MAN8900 Series is a family of large digits 0.8-inches in height. This series combines high brightness, large size, good aesthetics and is designed to be used where accurate readable displays need to be viewed over a distance. All models use right hand decimal points.

FEATURES

- High performance nitrogen-doped GaAsP on GaP
- Large, easy to read, digits
- Common anode or common cathode models
- Fast switching — excellent for multiplexing
- Low power consumption
- Bold solid segments that are highly legible
- Solid state reliability — long operation life
- Rugged plastic construction
- Directly compatible with integrated circuits
- High brightness with high contrast
- Categorized for Luminous Intensity (See Note 6)
- Wide angle viewing ... 150°
- Low forward voltage
- Red face and Red segment for good ON or OFF contrast
- These devices have a Red face and Red segments

APPLICATIONS

For industrial and consumer applications such as:

- Digital readout displays
- Instrument panels
- Point of sale equipment
- Digital clocks
- TV and radios

MODEL NUMBERS

PART NUMBER	COLOR	DESCRIPTION	PACKAGE DRAWING
MAN8910	High Efficiency Red	Common Anode; Right Hand Decimal	1
MAN8940	High Efficiency Red	Common Cathode; Right Hand Decimal	1

RECOMMENDED FILTERS

For optimum ON and OFF contrast, one of the following filters or equivalents should be used over the display:

Panelgraphic Scarlet 65
Homalite 100-1670

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous Intensity, digit average (See Note 1)	600	2200		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength		635		nm	
Spectral line half width		40		nm	
Forward voltage					
Segment			2.5	V	$I_F = 20 \text{ mA}$
Decimal point			2.5	V	$I_F = 20 \text{ mA}$
Dynamic resistance					
Segment		26		Ω	$I_F = 20 \text{ mA}$
Decimal point		26		Ω	$I_F = 20 \text{ mA}$
Capacitance					
Segment		35		pF	$V = 0$
Decimal point		35		pF	$V = 0$
Reverse current					
Segment			100	μA	$V_R = 3.0 \text{ V}$
Decimal point			100	μA	$V_R = 3.0 \text{ V}$
Luminous Intensity Ratio I_L (segment-to-segment)			2:1	—	$I_F = 10 \text{ mA}$

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient	600 mW
Derate linearly from 50°C	—8.6 mW/°C
Storage and operating temperature	—40°C to +85°C
Continuous forward current	
Total	240 mA
Per segment	30 mA
Decimal point	30 mA
Reverse voltage	
Per segment	6.0 V
Decimal point	6.0 V
Soldering time at 260°C (See Note 4)	5 sec.
Peak forward current per segment (I_{max}) (See Figure 4)	—

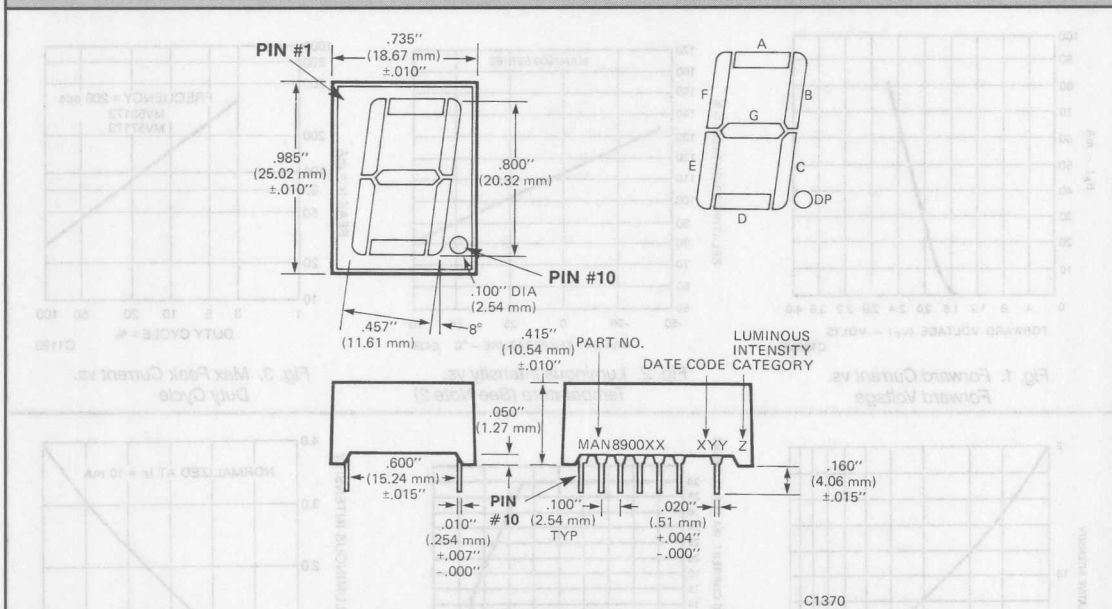
TYPICAL THERMAL CHARACTERISTICS

Thermal resistance junction to free air Φ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0Å/°C
Forward voltage temperature coefficient	—2.0 mV/°C

NOTES

1. The digit average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. Intensity will not vary more than $\pm 33.3\%$ between all segments within a digit.
2. The curve in Figure 3 is normalized to the brightness at 25°C to indicate the relative efficiency over the operating temperature range.
3. Leads of the device immersed to 1/16 inch from the body. Maximum device surface temperature is 140°C.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used up to their boiling points.
5. All displays are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.

PACKAGE DIMENSIONS



ELECTRICAL CONNECTIONS

ELECTRICAL CONNECTIONS		
MAN8910		MAN8940
	Digit	Digit
	Common Anode	Common Cathode
PIN #	Package Dimensions	Package Dimensions
1	No Connection	No Connection
2	A Cathode	A Anode
3	F Cathode	F Anode
4	Common Anode	Common Cathode
5	E Cathode	E Anode
6	—	—
7	E Cathode	E Anode
8	—	—
9	D Cathode	Common Cathode
10	DP Cathode	DP Anode
11	D Cathode	D Anode
12	Common Anode	Common Cathode
13	C Cathode	C Anode
14	G Cathode	G Anode
15	B Cathode	B Anode
16	—	—
17	Common Anode	Common Cathode
18	—	—

TYPICAL CHARACTERISTIC CURVES

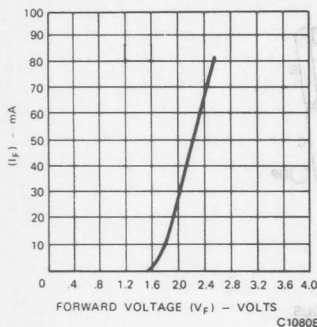


Fig. 1. Forward Current vs. Forward Voltage

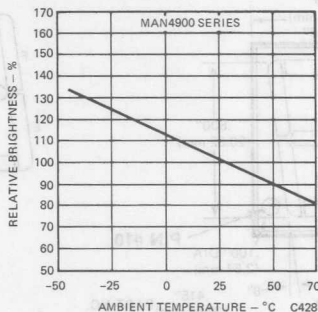


Fig. 2. Luminous Intensity vs. Temperature (See Note 2)

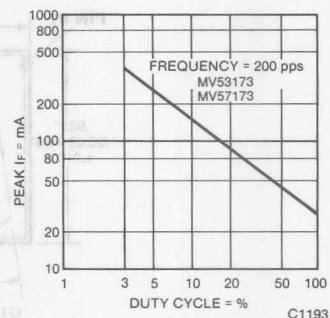


Fig. 3. Max Peak Current vs. Duty Cycle

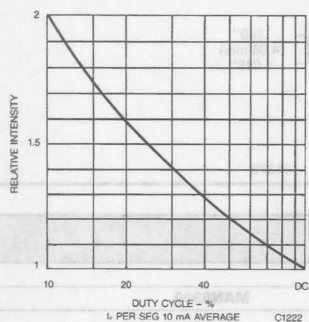


Fig. 4. Luminous Intensity vs. Duty Cycle

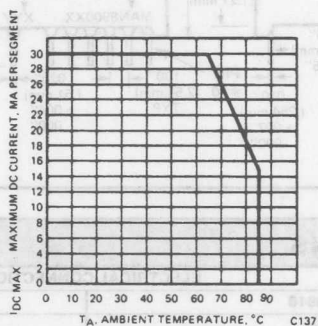


Fig. 5. Maximum DC Current vs. Temperature

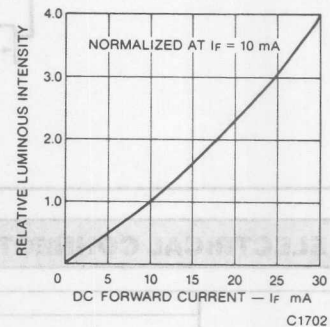
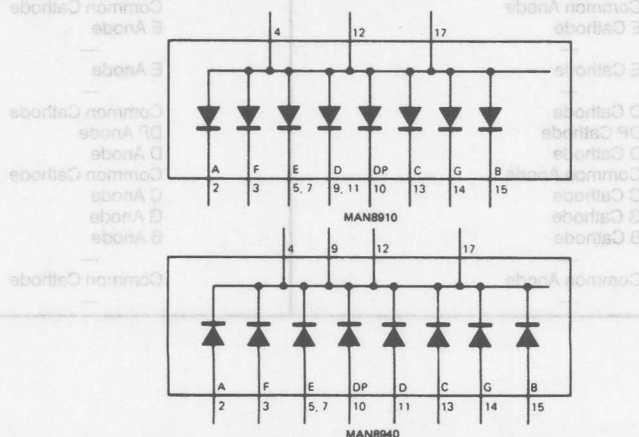


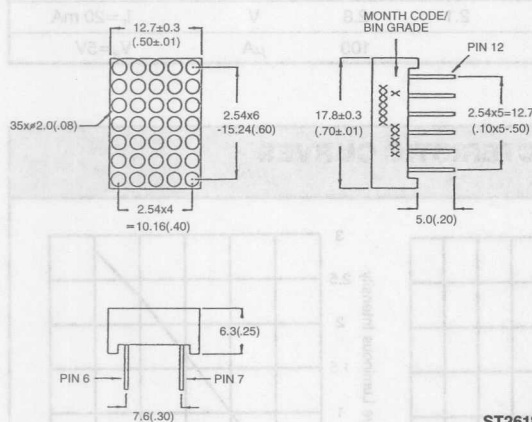
Fig. 6. Relative Luminous Intensity vs. Forward Current

INTERNAL CONNECTIONS



HER GMA 7175C GMC 7175C
YELLOW GMA 7475C GMC 7475C
GREEN GMA 7975C GMC 7975C

PACKAGE DIMENSIONS



NOTES:
1. ALL PINS ARE 00.5 (.02).
2. DIMENSION IN MILLIMETERS (INCH), TOLERANCE IS 0.25 (.01) UNLESS OTHERWISE NOTED.

DESCRIPTION

The GMX7X75C series are 0.7" (17.2mm) matrix height 5 X 7 dot matrix displays. All these parts are available in grey face and white dot color.

The X in GMX denotes row anode or row cathode.

FEATURES

- 0.7" (17.8mm) matrix height
- Choice of 3 colors — green, yellow and HER
- Low power consumption
- 5x7 array with X-Y select
- Stackable vertically and horizontally
- Choice of 2 matrix orientation cathode column or anode column
- Easy mounting on PCB or sockets
- Categorized for luminous intensity

ABSOLUTE MAXIMUM RATING ($T_A=25^\circ\text{C}$ unless otherwise specified)

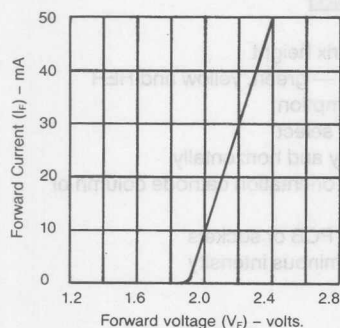
	YELLOW	HER	GREEN	UNITS
Power dissipation per dot	60	70	75	mW
Peak forward current per dot	80	100	100	mA
(Duty cycle 1/10, 10KHz)				
Continuous I_F per dot	20	25	25	mA
Reverse voltage per dot	5	5	5	V
Operating and operating temperature range	-25°C to $+85^\circ\text{C}$			
Soldering time at 260°C (1/16 inch below seating plane)	3 sec			

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 7175C (HER)

PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		635		nm	$I_F = 20\text{ mA}$
Spectral line half-width		40		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{V}$

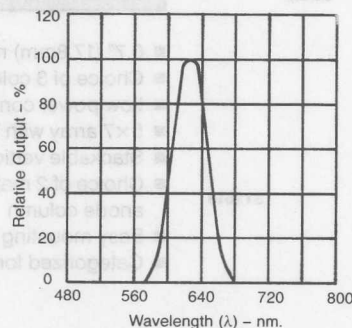
TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)



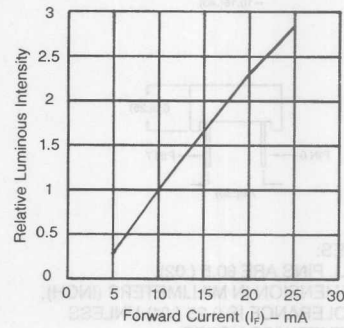
C3031

Fig. 1. Forward Current vs. Forward Voltage



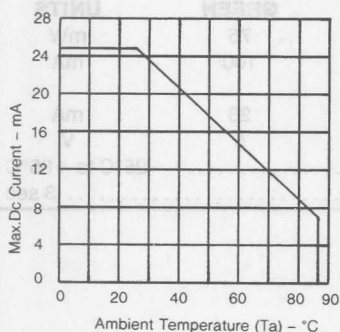
C3032

Fig. 2. Spectral Response



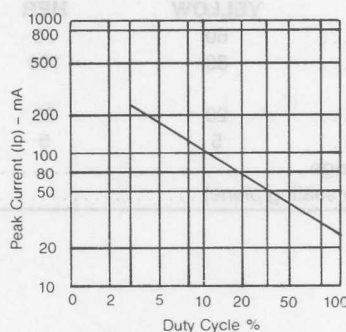
C3033

Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)



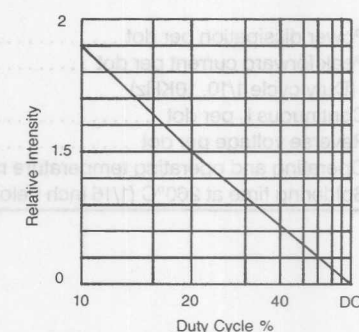
C3034

Fig. 4. Max. Forward Allowable DC Current Per Seg. vs. Ambient Temperature



C3035

Fig. 5. Max. Peak Current vs. Duty Cycle %
(Refresh Rate $F = 1\text{ KHz}$)



C3036

Fig. 6. Luminous Intensity vs. Duty Cycle %
(Average $I = 10\text{ mA Per Seg.}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless otherwise specified)
GMX 7475C (YELLOW)

PARAMETER	TEST	UNIT	MAX	TYP	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		μcd		3000					$I_F=20\text{ mA}$
Peak emission wavelength		nm		585					$I_F=20\text{ mA}$
Spectral line half-width		nm		30					$I_F=20\text{ mA}$
Forward voltage, any dot		V	2.8	2.1			2.8		$I_F=20\text{ mA}$
Reverse voltage, any dot		V	100						$V_R=5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES
($T_A=25^\circ\text{C}$ Unless Otherwise Noted)

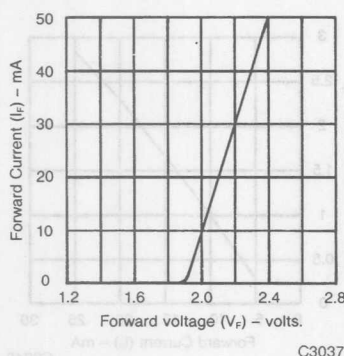


Fig. 1. Forward Current vs. Forward Voltage

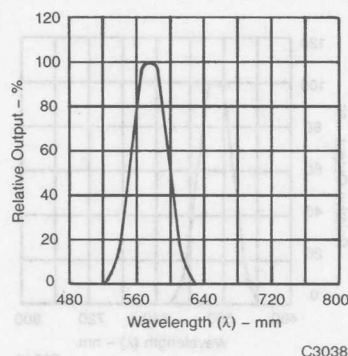


Fig. 2. Spectral Response

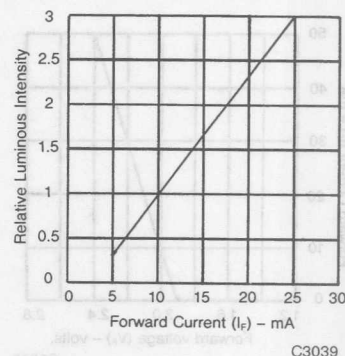


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

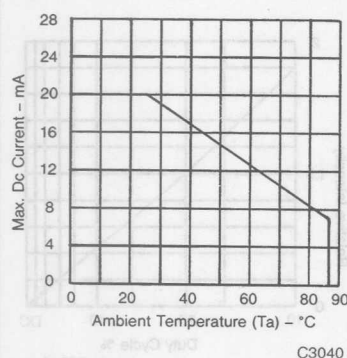


Fig. 4. Max. Forward Allowable DC Current Per Seg. vs. Ambient Temperature

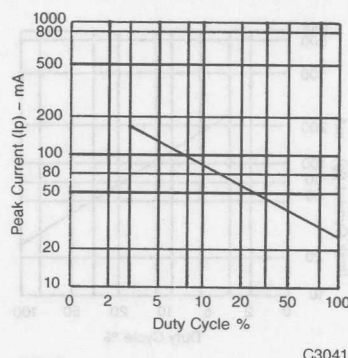


Fig. 5. Max. Peak Current vs. Duty Cycle % (Refresh Rate - $F=1\text{ KHz}$)

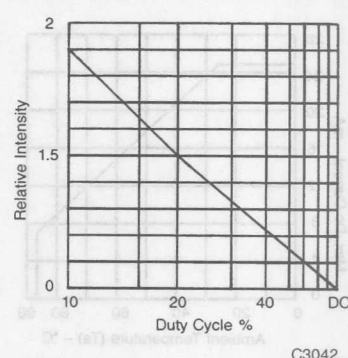


Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I=10\text{ mA Per Seg.}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 7975C (GREEN)

PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		565		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

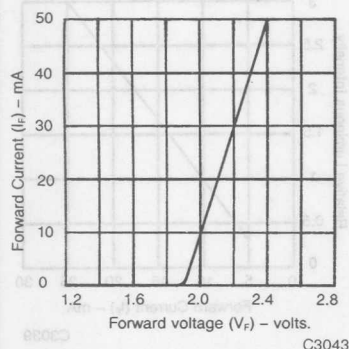


Fig. 1. Forward Current vs. Forward Voltage

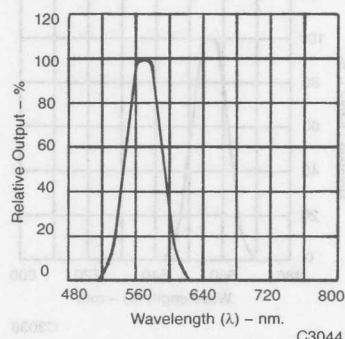


Fig. 2. Spectral Response

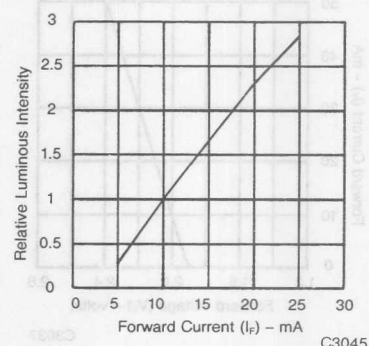


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

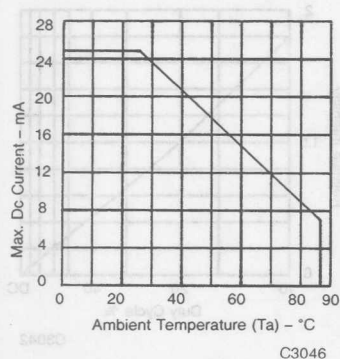


Fig. 4. Max. Forward Allowable DC Current Per Seg. vs. Ambient Temperature

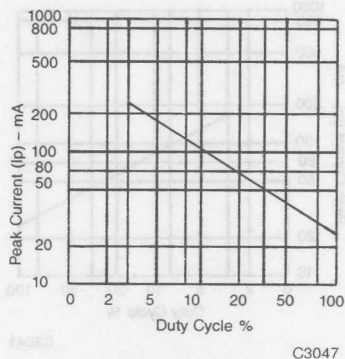


Fig. 5. Max. Peak Current vs. Duty Cycle %
(Refresh Rate - $F = 1\text{ KHz}$)

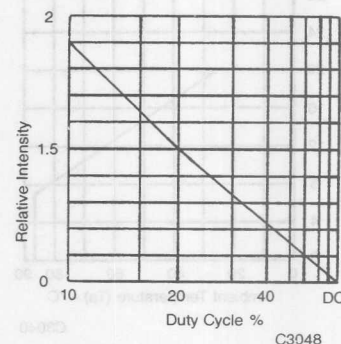
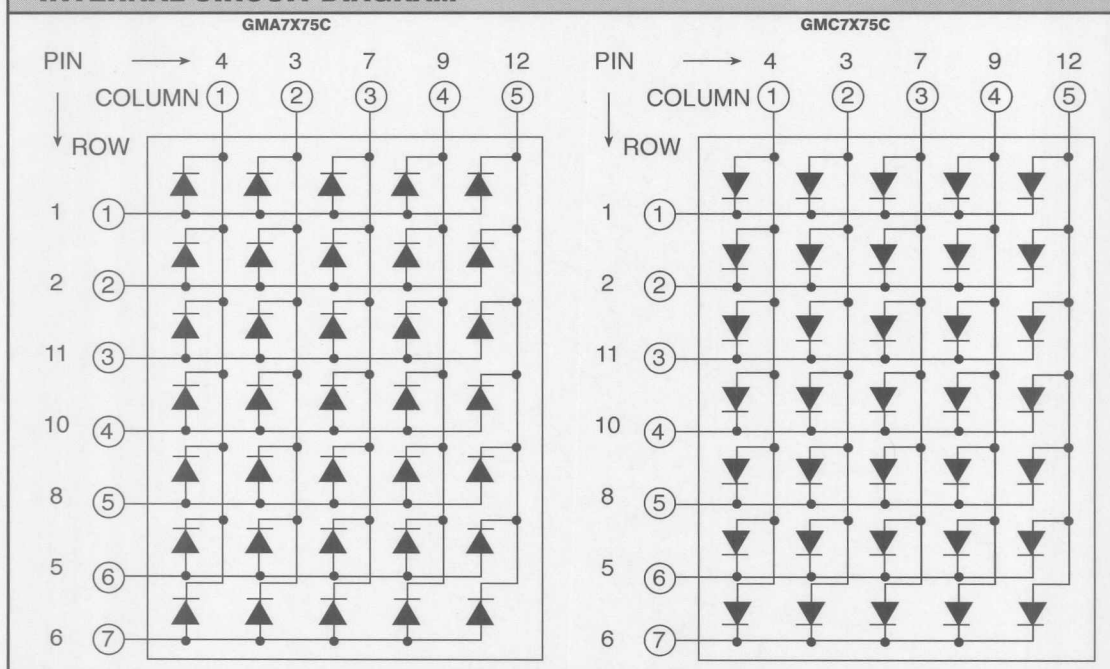


Fig. 6. Luminous Intensity vs. Duty Cycle %
(Average $I = 10\text{ mA Per Seg.}$)

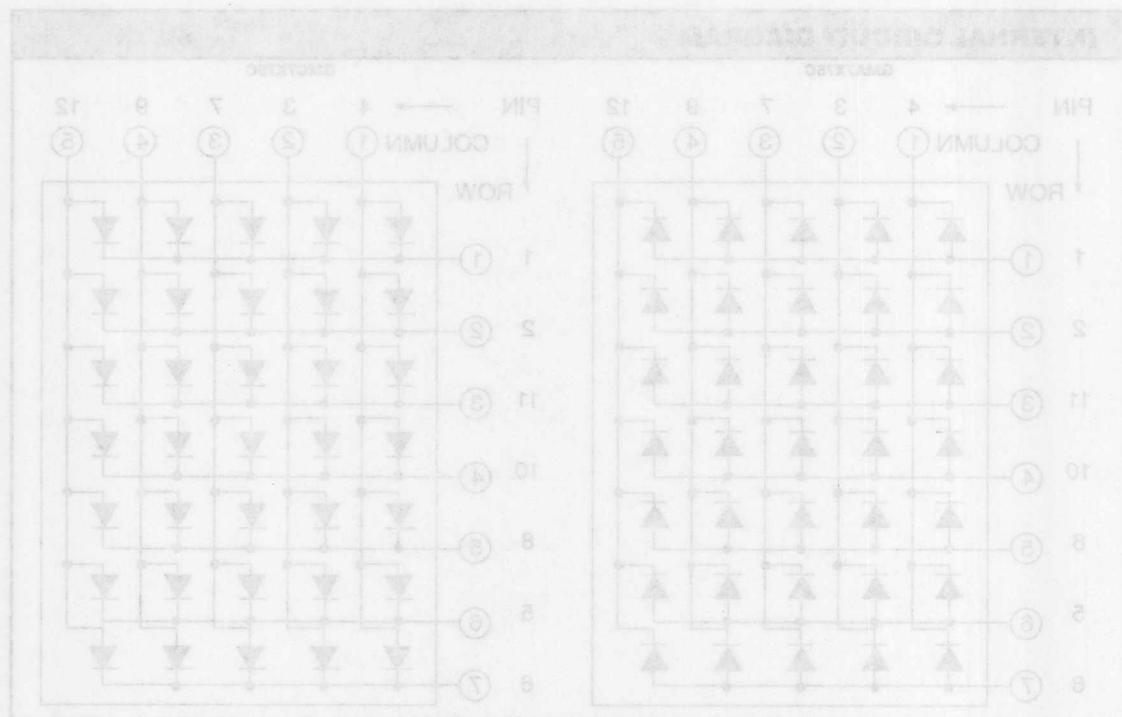
PIN CONNECTION

PIN NO.	GMA7X75C	GMC7X75C
1	Anode row 1	Cathode row 1
2	Anode row 2	Cathode row 2
3	Cathode column 2	Anode column 2
4	Cathode column 1	Anode column 1
5	Anode row 6	Cathode row 6
6	Anode row 7	Cathode row 7
7	Cathode column 3	Anode column 3
8	Anode row 5	Cathode row 5
9	Cathode column 4	Anode column 4
10	Anode row 4	Cathode row 4
11	Cathode row 3	Anode row 3
12	Cathode row 5	Anode row 5

INTERNAL CIRCUIT DIAGRAM

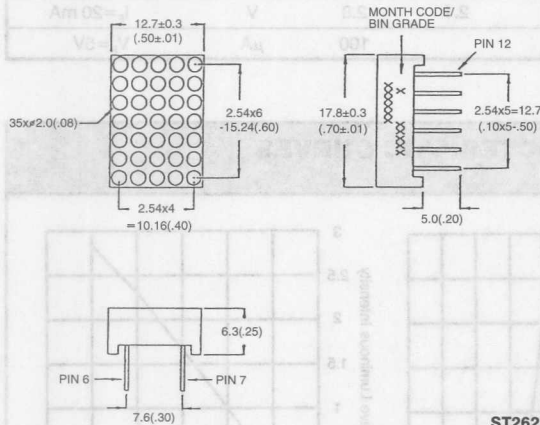


PIN NO.	CATHODE	ANODE
1	Row 1	Column 1
2	Row 2	Column 2
3	Row 3	Column 3
4	Row 4	Column 4
5	Row 5	Column 5
6	Row 6	Column 6
7	Row 7	Column 7
8	Row 8	Column 8
9	Row 9	Column 9
10	Row 10	Column 10
11	Row 11	Column 11
12	Row 12	Column 12



HER GMA 7175CA GMC 7175CA
YELLOW GMA 7475CA GMC 7475CA
GREEN GMA 7975CA GMC 7975CA

PACKAGE DIMENSIONS



NOTES:

1. ALL PINS ARE 00.5 (.02).
2. DIMENSION IN MILLIMETERS (INCH), TOLERANCE IS 0.25 (.01) UNLESS OTHERWISE NOTED.

DESCRIPTION

The GMX7X75CA series are 0.7" (17.2mm) matrix height 5 X 7 dot matrix displays. All these parts are available in grey face and white dot color.

The X in GMX denotes row anode or row cathode.

FEATURES

- 0.7" (17.8mm) matrix height
- Choice of 3 colors — green, yellow and HER
- Low power consumption
- 5 X 7 array with X-Y select
- Stackable vertically and horizontally
- Choice of 2 matrix orientation cathode column or anode column
- Easy mounting on PCB or sockets
- Categorized for luminous intensity

ABSOLUTE MAXIMUM RATING ($T_A=25^{\circ}\text{C}$ unless otherwise specified)

	YELLOW	HER	GREEN	UNITS
Power dissipation per dot	60	70	75	mW
Peak forward current per dot (Duty cycle 1/10, 10KHz)	80	100	100	mA
Continuous I_F per dot	20	25	25	mA
Reverse voltage per dot	5	5	5	V
Operating and operating temperature range	-25°C to $+85^{\circ}\text{C}$			
Soldering time at 260°C (1/16 inch below seating plane)	3 sec			

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless otherwise specified)
GMX7175CA (HER)

PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F=20\text{ mA}$
Peak emission wavelength		635		nm	$I_F=20\text{ mA}$
Spectral line half-width		40		nm	$I_F=20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F=20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R=5\text{V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A=25^\circ\text{C}$ Unless otherwise specified)

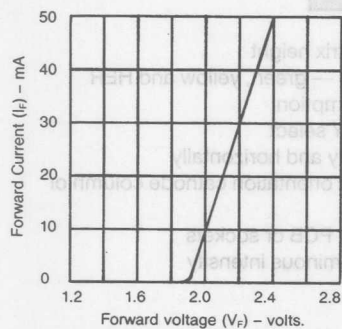


Fig. 1. Forward Current vs. Forward Voltage

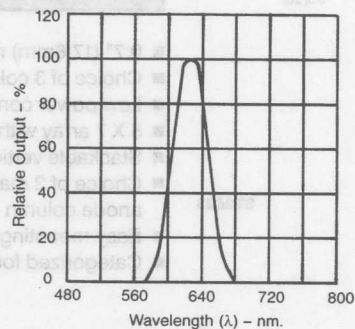


Fig. 2. Spectral Response

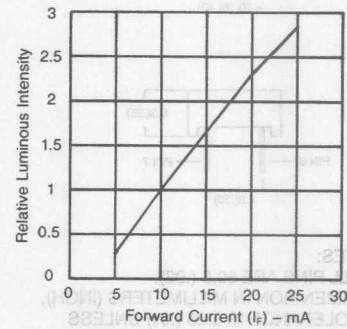


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

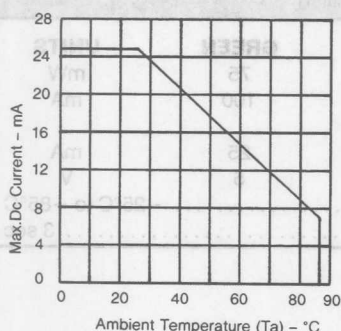


Fig. 4. Max. Forward Allowable DC Current Per Seg. vs. Ambient Temperature

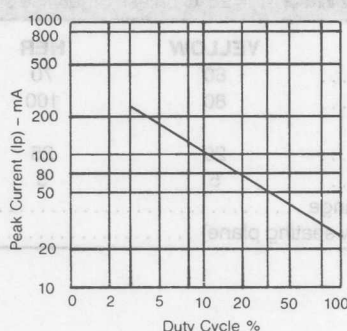


Fig. 5. Max. Peak Current vs. Duty Cycle %
(Refresh Rate $F=1\text{ KHz}$)

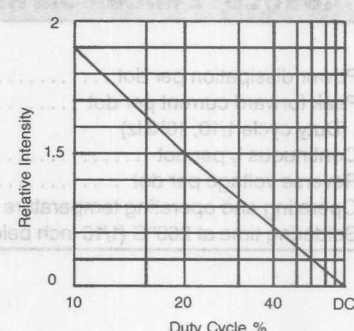


Fig. 6. Luminous Intensity vs. Duty Cycle %
(Average $I=10\text{ mA}$ Per Seg.)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless otherwise specified)
GMX 7475CA (YELLOW)

PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F=20\text{ mA}$
Peak emission wavelength		585		nm	$I_F=20\text{ mA}$
Spectral line half-width		35		nm	$I_F=20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F=20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R=5\text{V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A=25^\circ\text{C}$ Unless Otherwise Noted)

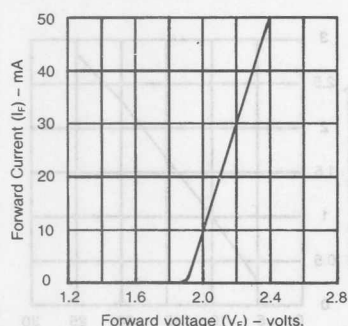


Fig. 1. Forward Current vs. Forward Voltage

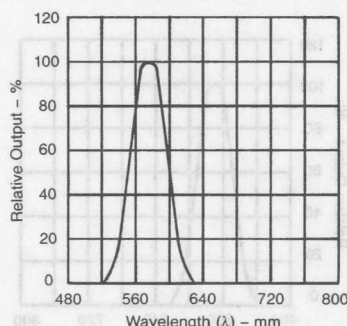


Fig. 2. Spectral Response

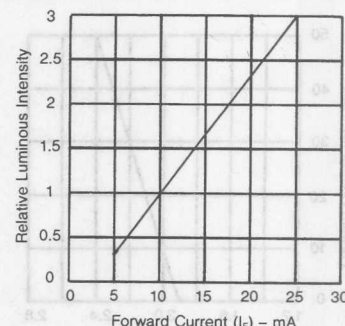


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

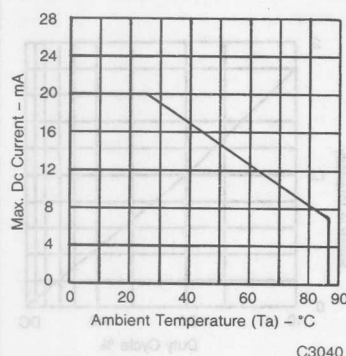


Fig. 4. Max. Forward Allowable DC Current Per Seg. vs. Ambient Temperature

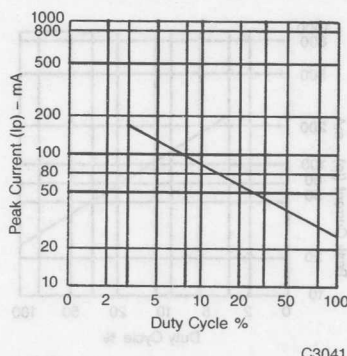


Fig. 5. Max. Peak Current vs. Duty Cycle % (Refresh Rate $F=1\text{ KHz}$)

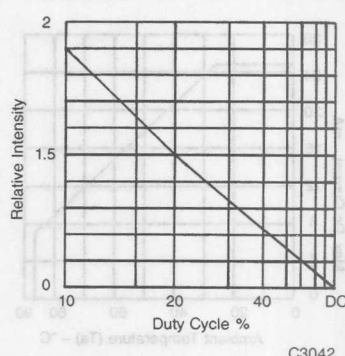


Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I=10\text{ mA Per Seg.}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless otherwise specified)
GMX 7975CA (GREEN)

PARAMETER	TEST	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity			3000		μcd	$I_F=20\text{ mA}$
Peak emission wavelength			565		nm	$I_F=20\text{ mA}$
Spectral line half-width			30		nm	$I_F=20\text{ mA}$
Forward voltage, any dot	V		2.1	2.8	V	$I_F=20\text{ mA}$
Reverse voltage, any dot	V			100	μA	$V_R=5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A=25^\circ\text{C}$ Unless otherwise specified)

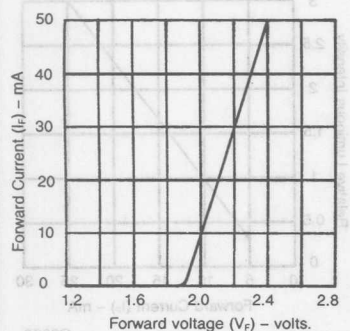


Fig. 1. Forward Current vs. Forward Voltage

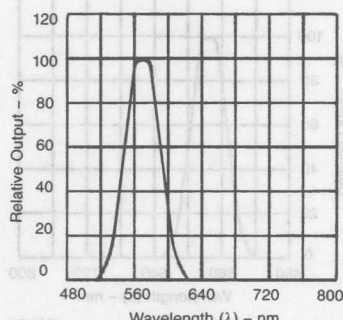


Fig. 2. Spectral Response

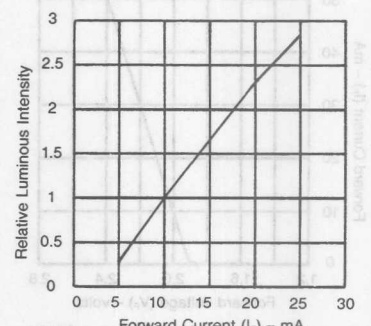


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

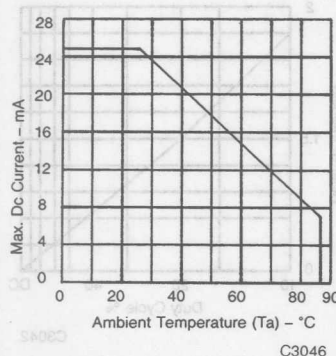


Fig. 4. Max. Forward Allowable DC Current Per Seg. vs. Ambient Temperature

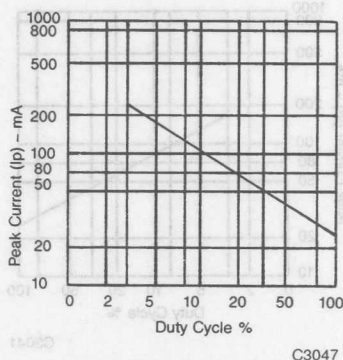


Fig. 5. Max. Peak Current vs. Duty Cycle %
(Refresh Rate $F=1\text{ KHz}$)

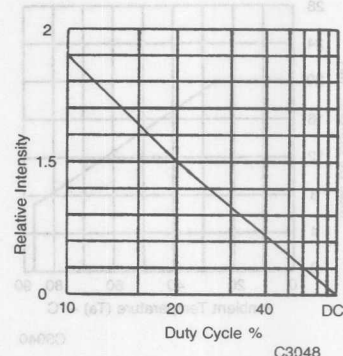
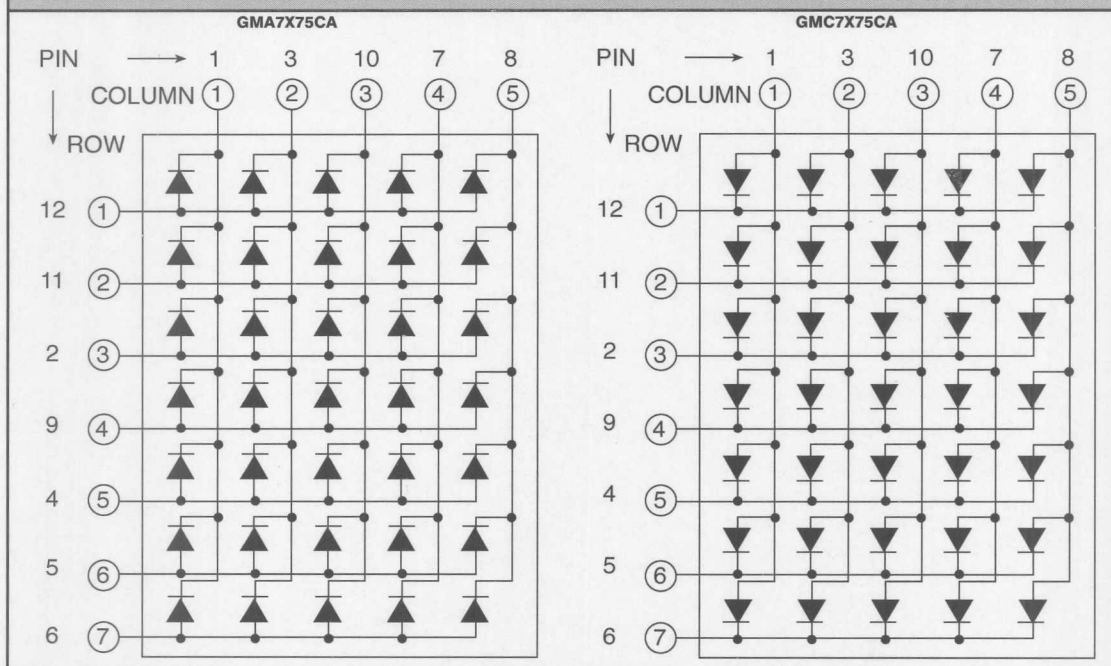


Fig. 6. Luminous Intensity vs. Duty Cycle %
(Average $I=10\text{ mA Per Seg.}$)

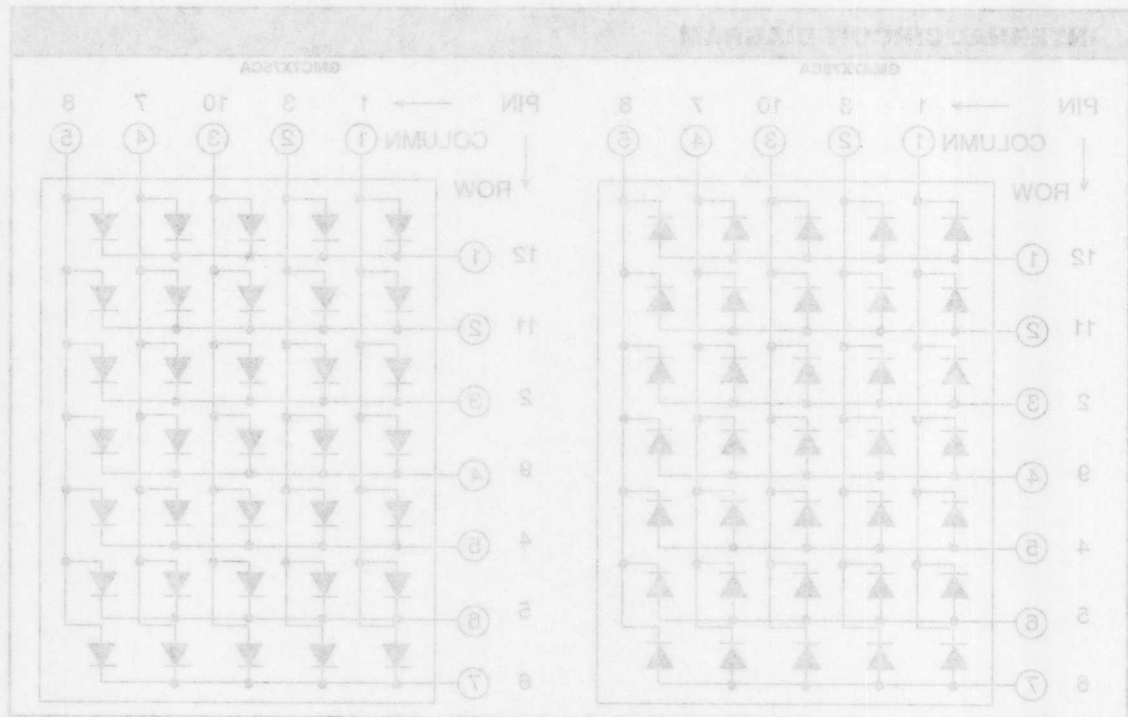
PIN CONNECTION

PIN NO.	GMA7X75CA	GMC7X75CA
1	Cathode column 1	Anode column 1
2	Anode row 3	Cathode row 3
3	Cathode column 2	Anode column 2
4	Anode row 5	Cathode row 5
5	Anode row 6	Cathode row 6
6	Anode row 7	Cathode row 7
7	Cathode column 4	Anode column 4
8	Cathode column 5	Anode column 5
9	Anode row 4	Cathode row 4
10	Cathode column 3	Anode column 3
11	Anode row 2	Cathode row 2
12	Anode row 1	Cathode row 1

INTERNAL CIRCUIT DIAGRAM



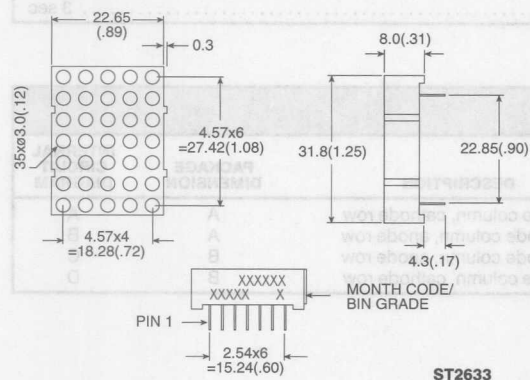
PIN CONNECTION		
PIN NO.	GMATX50CA	GMATX50CA
1	Cathode column 1	Anode column 1
2	Anode row 3	Cathode row 3
3	Cathode column 2	Anode column 2
4	Anode row 5	Cathode row 5
5	Anode row 6	Cathode row 6
6	Anode row 7	Cathode row 7
7	Cathode column 4	Anode column 4
8	Cathode column 5	Anode column 5
9	Anode row 4	Cathode row 4
10	Cathode column 3	Anode column 3
11	Anode row 2	Cathode row 2
12	Anode row 1	Cathode row 1



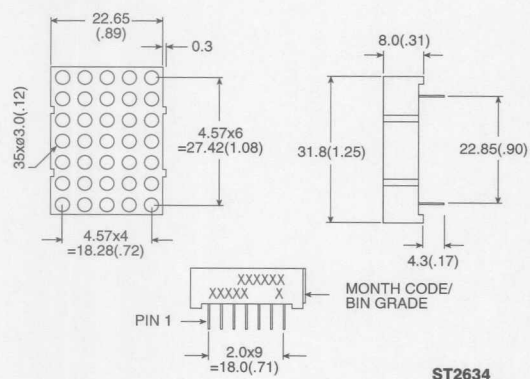
YELLOW GMA 8475C GMC 8475C
HER GMA 8875C GMC 8875C
GREEN GMA 8975C GMC 8975C
BICOLOR- RED/GREEN GMA 8675C GMC 8675C

PACKAGE DIMENSIONS

A. GMX8X75C



B. GMX8675C



NOTES:

1. ALL PINS ARE 60.5 (.02).
2. DIMENSIONS IN MILLIMETER (INCH), TOLERANCE IS ± 0.25 (.01) UNLESS OTHERWISE NOTED.

DESCRIPTION

The GMX8X75C series are 1.2" (30 mm) matrix height 5 × 7 dot matrix displays. All these parts are available in gray face and white dot color.

The X in GMX denotes row anode or row cathode.

FEATURES

- 1.2" (30 mm) matrix height
- Choice of 3 colors — green, yellow & HER and bicolor — red/green
- Low power consumption
- 5 × 7 array with X-Y select
- Stackable horizontally
- Choice of 2 matrix orientation cathode column or anode column
- Easy mounting or PCB on sockets
- Categorized for luminous intensity
- Multicolor color displays are applicable to 3 bright colors — green, orange (HER) and yellow (green and HER mixed)

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ unless otherwise specified)

PARAMETER	YELLOW	HER	GREEN	UNITS
Power dissipation per dot	60	70	75	mW
Peak forward current per dot (Duty cycle 1/10, 10KHz)	80	100	100	mA
Continuous I_F per dot	20	5	25	mA
Reverse voltage per dot	5	5	5	V
Operating and storage temperature range	-25°C to $+85^\circ\text{C}$			
Soldering time at 260°C ($\frac{1}{16}$ inch below seating plane)	3 sec			

MODEL NUMBERS

PART NO.			DESCRIPTION	PACKAGE DIMENSION	INTERNAL CIRCUIT DIAGRAM
YELLOW	HER	GREEN			
GMC8475C	GMC8875C	GMC8975C	Anode column, cathode row	A	A
GMA8475C	GMA8875C	GMA8975C	Cathode column, anode row	A	B
		GMA8675C	Cathode column, anode row	B	C
		GMC8675C	Anode column, cathode row	B	D

GMA 8X75C GMC 8X75C

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX8475C (YELLOW)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		585		nm	$I_F = 20\text{ mA}$
Spectral line half-width		35		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

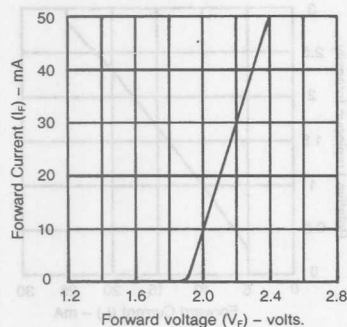


Fig. 1. Forward Current vs. Forward Voltage

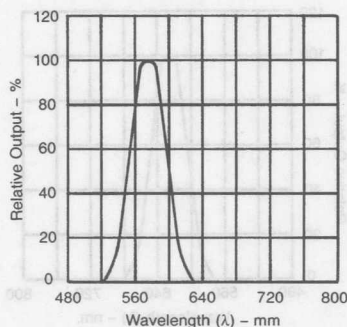


Fig. 2. Spectral Response

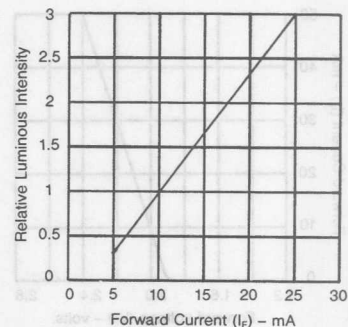


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

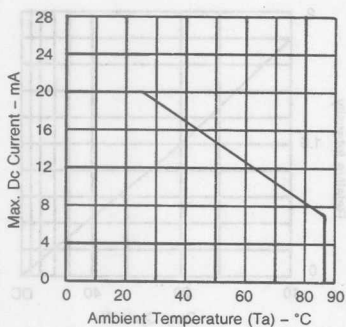


Fig. 4. Maximum Forward Allowable DC Current Per Segment vs. Ambient Temperature

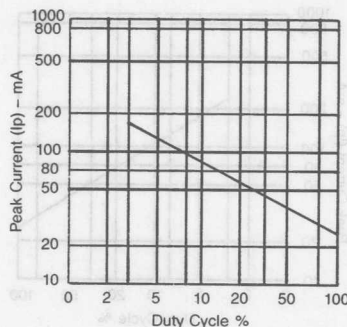


Fig. 5. Max Peak Current vs. Duty Cycle %
(Refresh Rate $f = 1\text{ KHz}$)

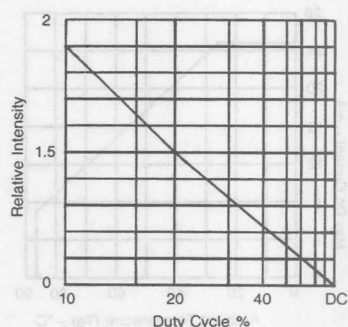


Fig. 6. Luminous Intensity vs. Duty Cycle %
(Average $I = 10\text{ mA}$ Per Seg.)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX8875C (HER)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		635		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

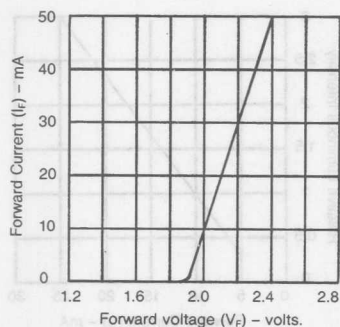


Fig. 1. Forward Current vs. Forward Voltage

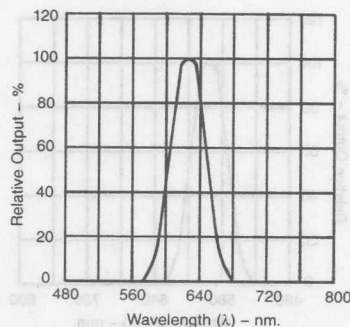


Fig. 2. Spectral Response

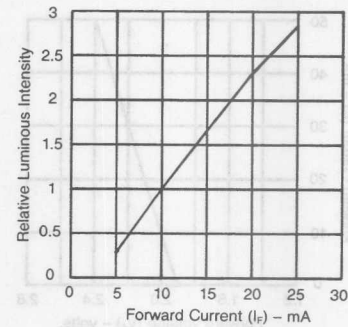


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

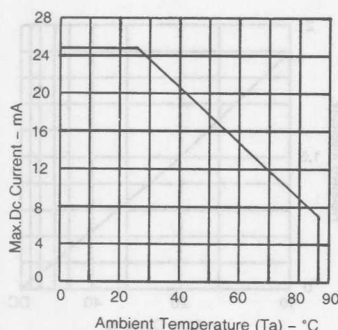


Fig. 4. Maximum Forward Allowable DC Current Per Segment vs. Ambient Temperature

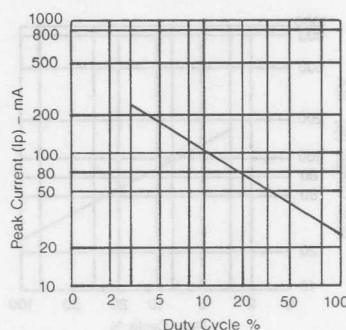


Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)

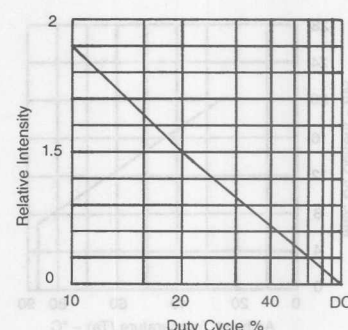


Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I = 10\text{ mA}$ Per Seg.)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX8975C (GREEN)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		565		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

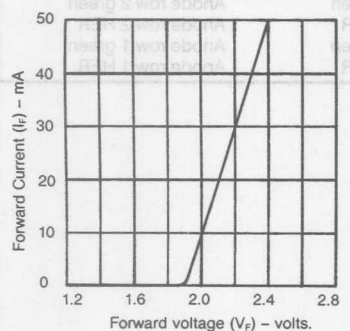


Fig. 1. Forward Current vs. Forward Voltage

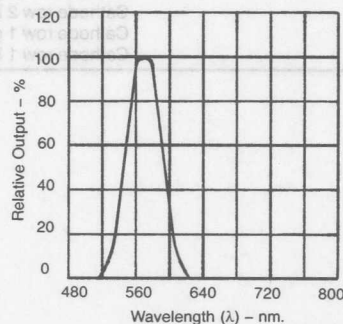


Fig. 2. Spectral Response

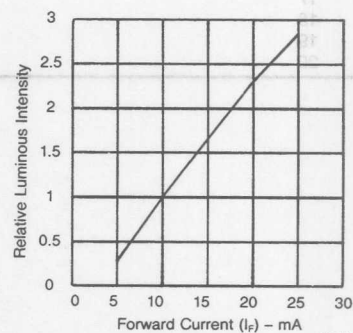


Fig. 3. Relative Luminous Intensity vs. Forward Current (Per Segment)

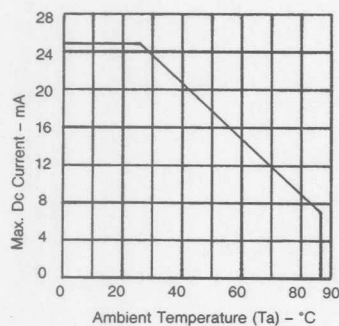


Fig. 4. Maximum Forward Allowable DC Current Per Segment vs. of Ambient Temperature

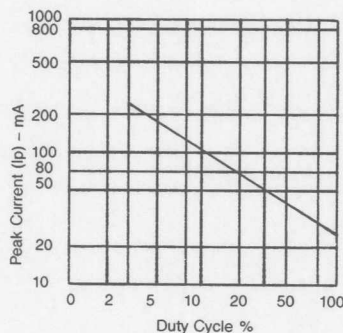


Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)

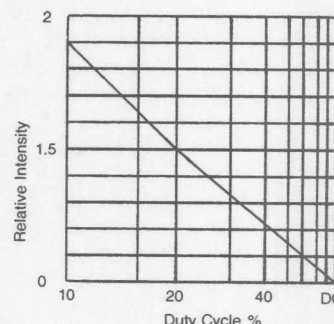


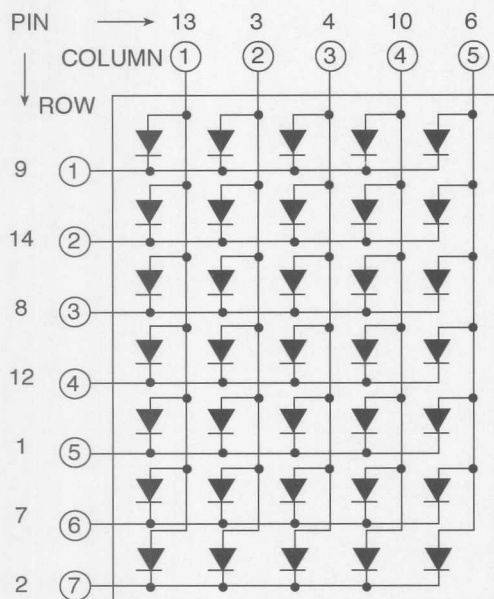
Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I = 10\text{ mA}$ Per Seg.)

PIN CONNECTION

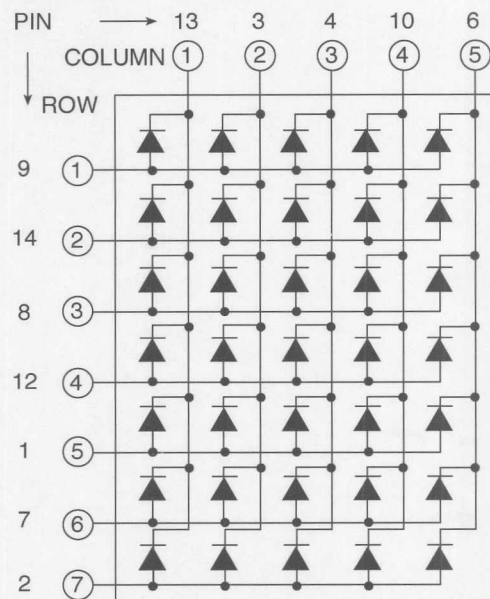
PIN NO.	GMA8X75C	GMC8X75C	GMC8675C	GMA8675C
1	Anode row 5	Cathode row 5	Cathode row 7 green	Anode row 7 green
2	Anode row 7	Cathode row 7	Cathode row 7 HER	Anode row 7 HER
3	Cathode column 2	Anode column 2	Anode column 1	Cathode column 1
4	Cathode column 3	Anode column 3	Anode column 2	Cathode column 2
5	Anode row 4	Cathode row 4	Anode column 3	Cathode column 3
6	Cathode column 5	Anode column 5	Anode column 4	Cathode column 4
7	Anode row 6	Cathode row 6	Anode column 5	Cathode column 5
8	Anode row 3	Cathode row 3	Cathode row 6 green	Anode row 6 green
9	Anode row 1	Cathode row 1	Cathode row 6 HER	Anode row 6 HER
10	Cathode column 4	Anode column 4	No connection	No connection
11	Cathode column 3	Anode column 3	Cathode row 5 green	Anode row 5 green
12	Anode row 4	Cathode row 4	Cathode row 5 HER	Anode row 5 HER
13	Cathode column 1	Anode column 1	Cathode row 4 green	Anode row 4 green
14	Anode row 2	Cathode row 2	Cathode row 4 HER	Anode row 4 HER
15			Cathode row 3 green	Anode row 3 green
16			Cathode row 3 HER	Anode row 3 HER
17			Cathode row 2 green	Anode row 2 green
18			Cathode row 2 HER	Anode row 2 HER
19			Cathode row 1 green	Anode row 1 green
20			Cathode row 1 HER	Anode row 1 HER

INTERNAL CIRCUIT DIAGRAM

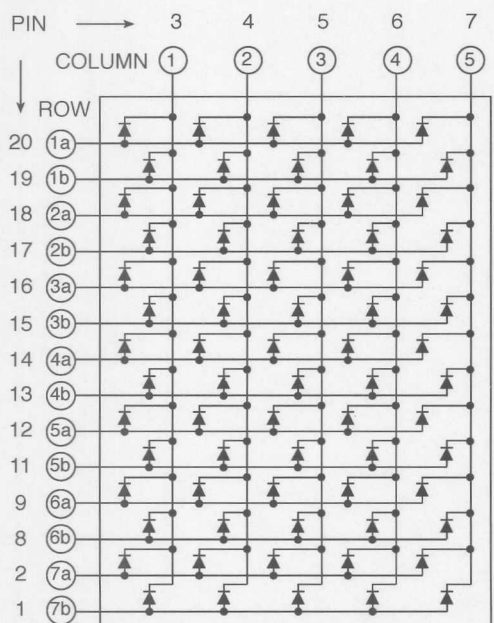
A. GMC8X75C



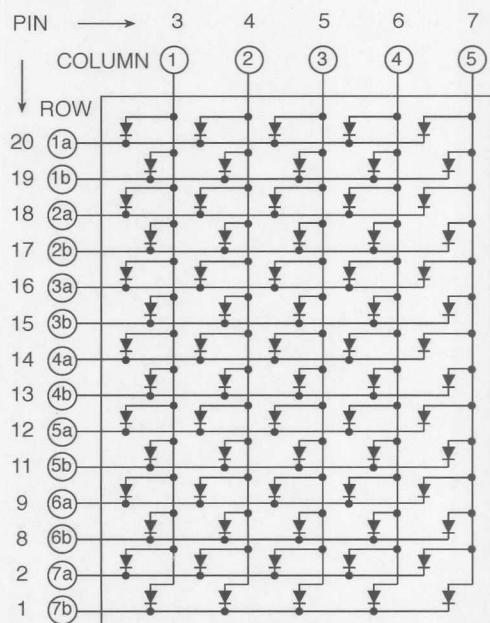
B. GMA8X75C



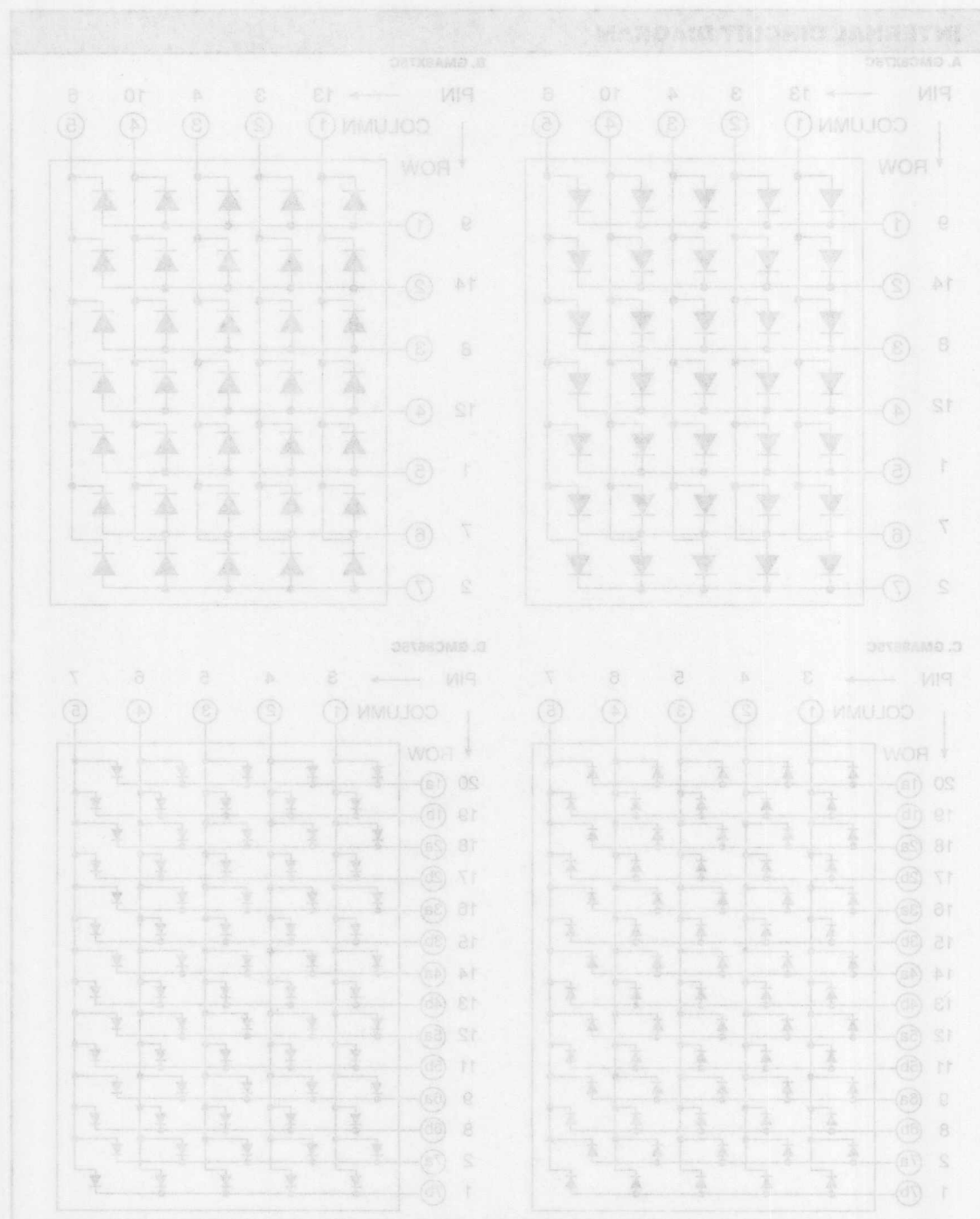
C. GMA8675C



D. GMC8675C



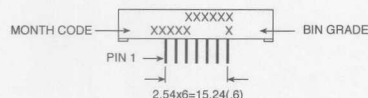
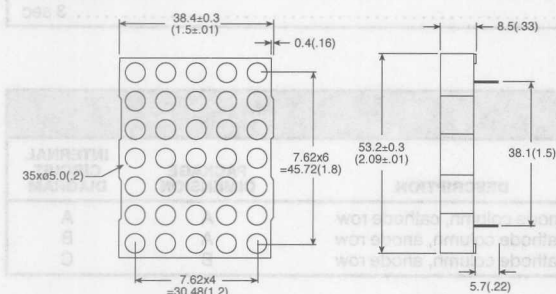
INTERNAL CIRCUIT DIAGRAM



YELLOW GMA 2875C GMC 2875C
HER GMA 2975C GMC 2975C
GREEN GMA 2475C GMC 2475C
BICOLOR RED/GREEN GMA 2675C

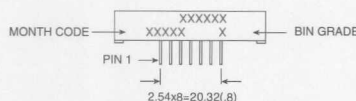
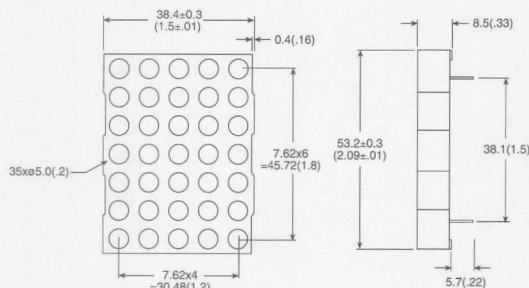
PACKAGE DIMENSIONS

A. GMX2X75C



ST2639

B. GMA2675C



ST2640

DESCRIPTION

These are 5×7 dot matrix displays with large emitting area (0.2" diameter) LED sources. The GMX2X75C series are single color displays with the exception of GMA2675C which is a bicolor of red/green displays. All displays have gray face and white dot color. Other face or dot colors are available with minimum requirement.

The X in GMX denotes row anode or row cathode.

FEATURES

- 2.0" (50.7 mm) character height
- Low power requirement
- High contrast & brightness
- Wide viewing angle 130°
- 5 × 7 array with X-Y select
- Compatible with USASCII and EBCDIC codes
- X-Y stackable
- Choice of two matrix orientation anode or cathode column
- Easy mounting on PCB
- Categorized for luminous intensity
- Single color displays have the choice of 3 bright colors — yellow/orange/green
- Multicolor color displays are applicable to 3 bright colors — greens, orange (HER) and yellow (green and HER mixed)

NOTES:

1. ALL PINS ARE 00.5 (.02).
2. DIMENSIONS IN MILLIMETERS (INCH), TOLERANCE IS ±0.25 (.01) UNLESS OTHERWISE NOTED.

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ unless otherwise specified)

PARAMETER	YELLOW	HER	GREEN	UNITS
Power dissipation per dot/color	60	70	75	mW
Peak forward current per dot/color (duty cycle 1/10, 10KHz)	80	100	100	mA
Continuous I_F per dot/color	20	25	25	mA
Reverse voltage V_R per dot/color	5	5	5	V
Operating and storage temperature range				-25°C to $+85^\circ\text{C}$
Soldering time at 260°C ($\frac{1}{16}$ inch below seating plane)				3 sec

MODEL NUMBERS

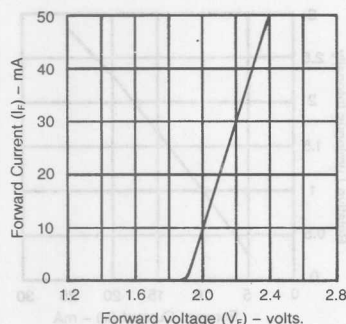
PART NO.			DESCRIPTION	PACKAGE DIMENSION	INTERNAL CIRCUIT DIAGRAM
YELLOW	HER	GREEN			
GMC2875C	GMC2975C	GMC2475C	Anode column, cathode row	A	A
GMA2875C	GMA2975C	GMA2475C	Cathode column, anode row	A	B
		GMA2675C	Cathode column, anode row	B	C

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2875C

PARAMETER	TEST	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity			3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength			585		nm	$I_F = 20\text{ mA}$
Spectral line half-width			30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot			2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot				100	μA	$V_R = 5\text{ V}$

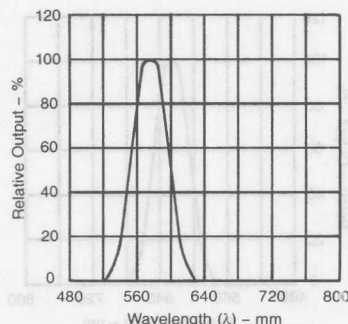
TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)



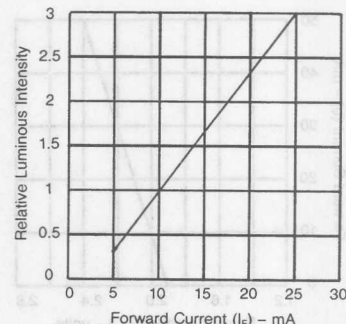
C3037

Fig. 1. Forward Current vs. Forward Voltage



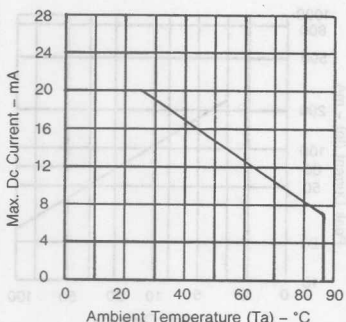
C3038

Fig. 2. Spectral Response



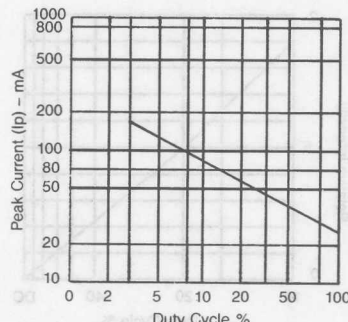
C3039

Fig. 3. Relative Luminous Intensity vs. Forward Current



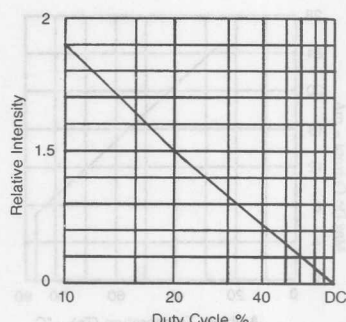
C3040

Fig. 4. Maximum Allowable DC Current Per Segment vs. Ambient Temperature



C3041

Fig. 5. Luminous Intensity vs. Duty Cycle



C3042

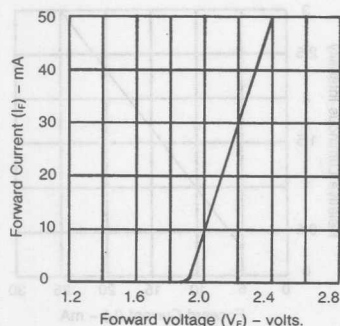
Fig. 6. Max Peak Current vs. Duty Cycle % (Refresh Rate $f=1\text{ KHz}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2975C

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		635		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

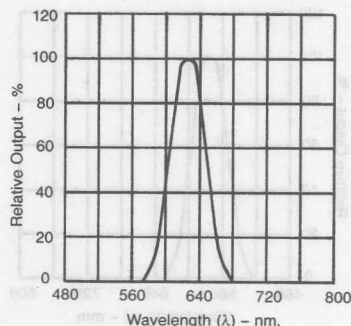
TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)



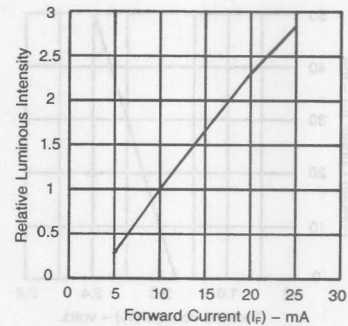
C3031

Fig. 1. Forward Current vs. Forward Voltage



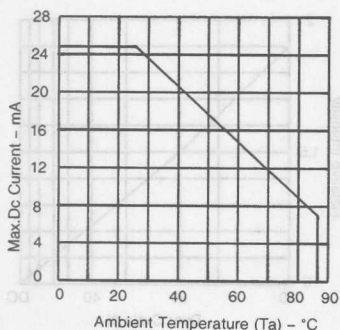
C3032

Fig. 2. Spectral Response



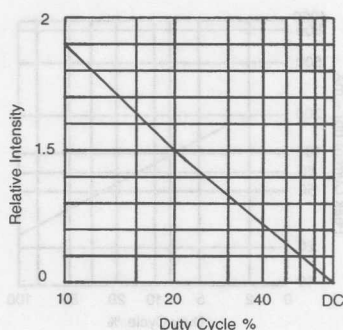
C3033

Fig. 3. Relative Luminous Intensity vs. Forward Current



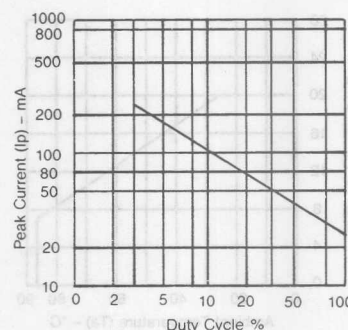
C3034

Fig. 4. Maximum Allowable DC Current Per Segment vs. A Function of Ambient Temperature



C3036

Fig. 5. Luminous Intensity vs. Duty Cycle



C3035

Fig. 6. Max. Peak Current vs. Duty Cycle % (Refresh Rate $f=1\text{ KHz}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2475C

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20 \text{ mA}$
Peak emission wavelength		565		nm	$I_F = 20 \text{ mA}$
Spectral line half-width		30		nm	$I_F = 20 \text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20 \text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5 \text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

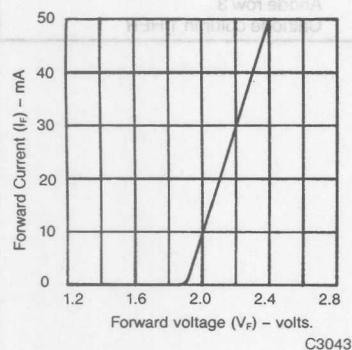


Fig. 1. Forward Current vs. Forward Voltage

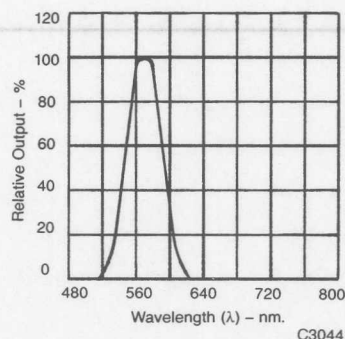


Fig. 2. Spectral Response

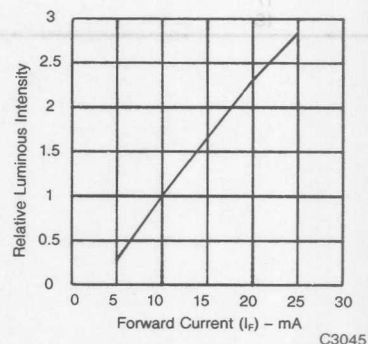


Fig. 3. Relative Luminous Intensity vs. Forward Current

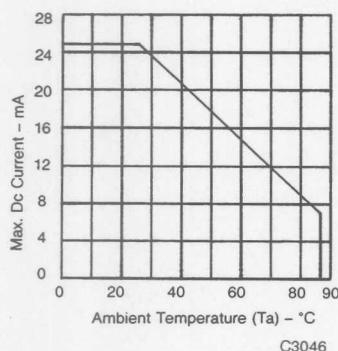


Fig. 4. Maximum Allowable DC Current Per Segment vs. A Function of Ambient Temperature

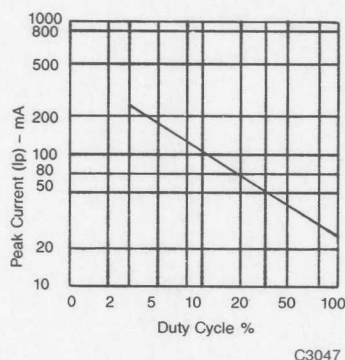


Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1 \text{ KHz}$)

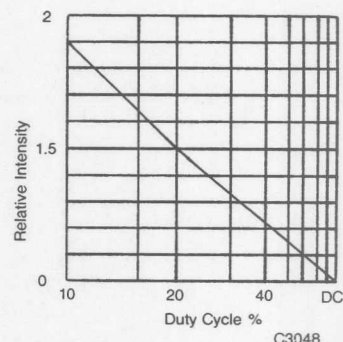
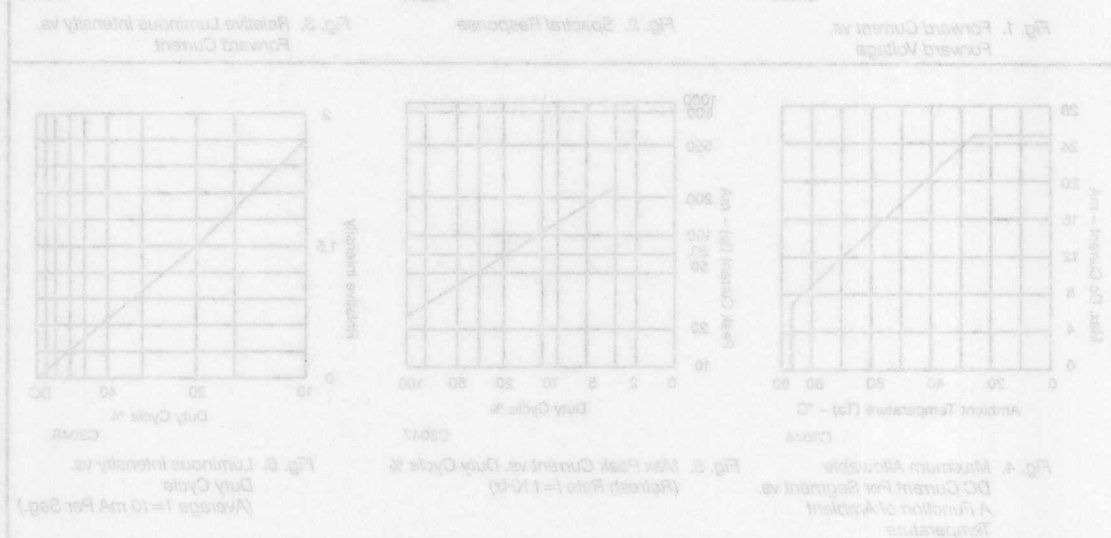
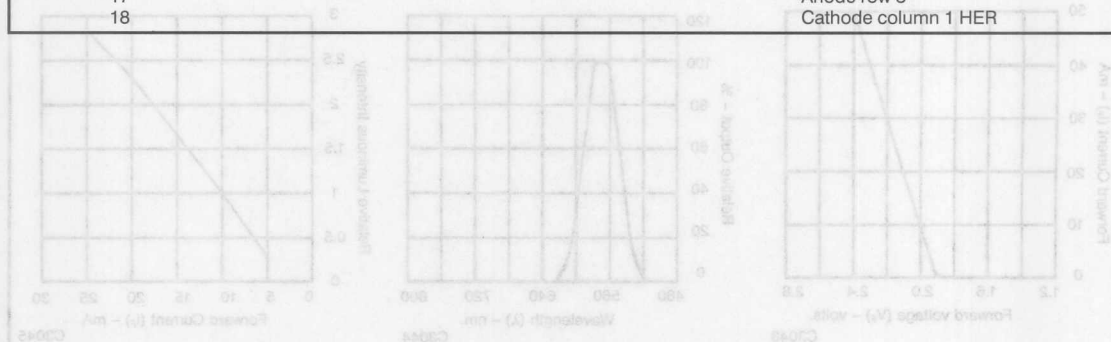


Fig. 6. Luminous Intensity vs. Duty Cycle (Average $I = 10 \text{ mA}$ Per Seg.)

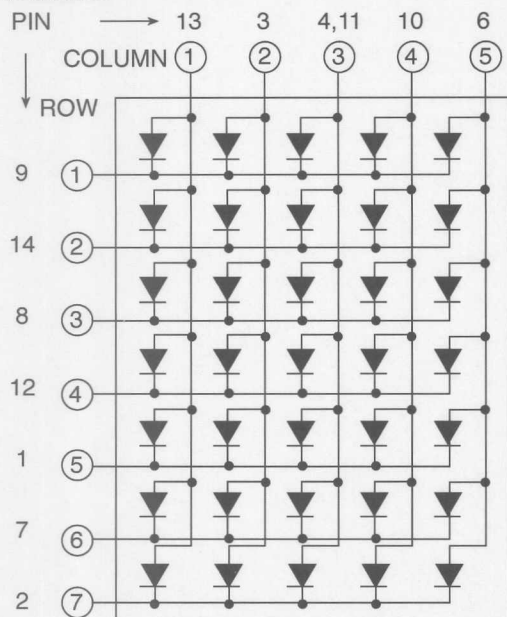
PIN CONNECTION

PIN NO.	GMC2X75C	GMA2X75C	GMA2675C
1	Cathode row 5	Anode row 5	Cathode column 1 green
2	Cathode row 7	Anode row 7	Cathode column 2 green
3	Anode column 2	Cathode column 2	Cathode column 2 HER
4	Anode column 3	Cathode column 3	Cathode column 3 HER
5	Cathode row 4	Anode row 4	Anode row 6
6	Anode column 5	Cathode column 5	Anode row 7
7	Cathode row 6	Anode row 6	Cathode column 4 HER
8	Cathode row 3	Anode row 3	Anode row 5
9	Cathode row 1	Anode row 1	No connection
10	Anode column 4	Cathode column 4	Cathode column 5 green
11	Anode column 3	Cathode column 3	Cathode column 5 HER
12	Cathode row 4	Anode row 4	Cathode column 4 green
13	Anode column 1	Cathode column 1	Anode column 3 green
14	Cathode row 2	Anode row 2	Anode row 4
15			Anode row 2
16			Anode row 1
17			Anode row 3
18			Cathode column 1 HER

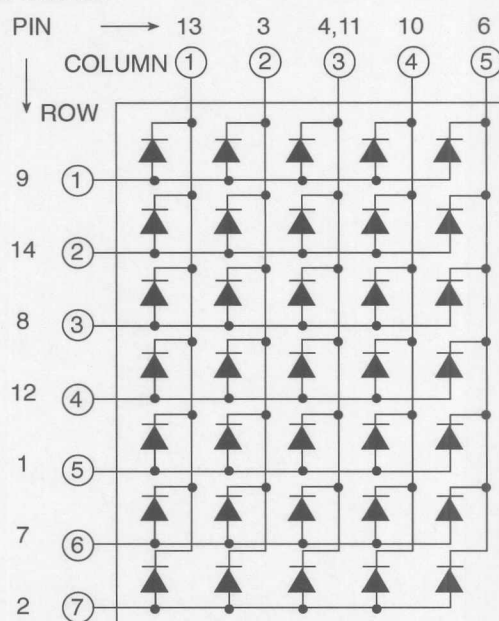


INTERNAL CIRCUIT DIAGRAM

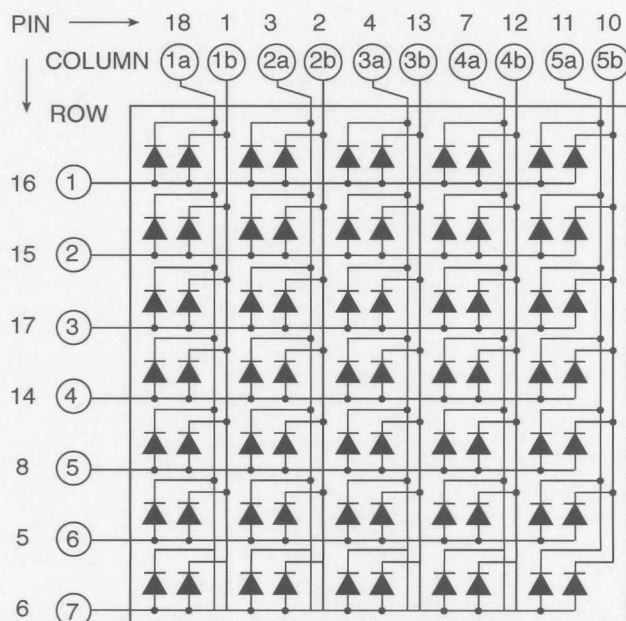
A. GMC2X75C

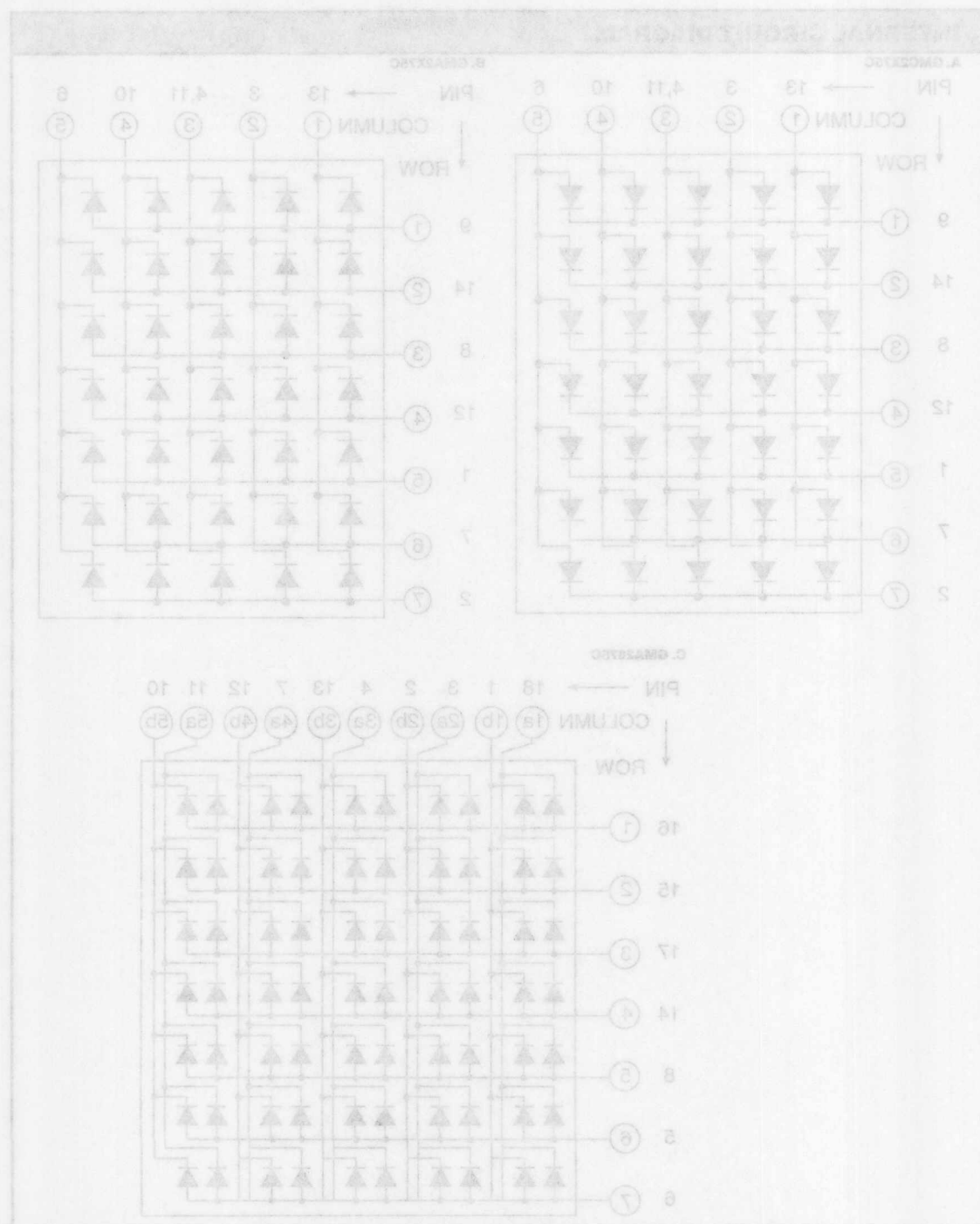


B. GMA2X75C



C. GMA2675C

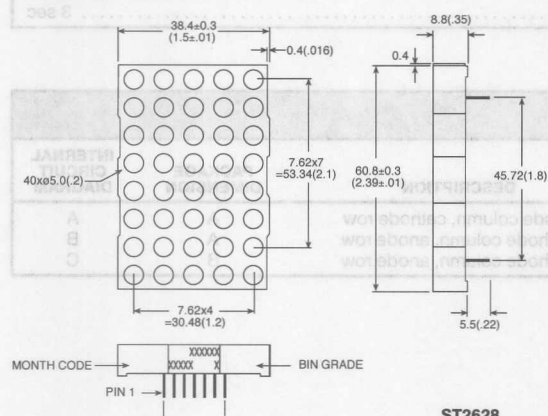




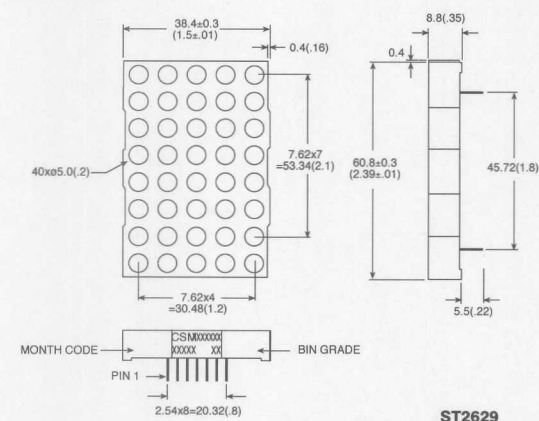
YELLOW GMA 2885C GMC 2885C
HER GMA 2985C GMC 2985C
GREEN GMA 2485C GMC 2485C
BICOLOR RED/GREEN GMA 2685C

PACKAGE DIMENSIONS

A. GMX2X85C



B. GMA2685C



NOTES:

1. ALL PINS ARE 90.5 (.02).
2. DIMENSIONS IN MILLIMETERS (INCH), TOLERANCE IS ±0.25 (.01) UNLESS OTHERWISE NOTED.

DESCRIPTION

These are 5×8 dot matrix displays with large emitting area (0.2" diameter) LED sources. The GMX2X85C series are single color displays with the exception of GMA2685C which is a bicolor of red/green displays.

All displays have gray face and white dot color. Other face or dot colors are available with minimum requirement.

The X in GMX denotes row anode or row cathode.

FEATURES

- 2.3" (58.4 mm) character height
- Low power requirement
- High contrast & brightness
- Wide viewing angle 130°
- 5 × 8 array with X-Y select
- Compatible with USASCII and EBCDIC codes
- X-Y stackable
- Choice of two matrix orientation anode or cathode column
- Easy mounting on PCB
- Categorized for luminous intensity
- Single color displays have the choice of 3 bright colors — yellow/orange/green
- Multicolor color displays are applicable to 3 bright colors — greens, orange (HER) and yellow (green and HER mixed)

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ unless otherwise specified)

PARAMETER	YELLOW	HER	GREEN	UNITS
Power dissipation per dot/color	60	70	75	mW
Peak forward current per dot/color (duty cycle 1/10, 10KHz)	80	100	100	mA
Continuous I_F per dot/color	20	25	25	mA
Reverse voltage V_R per dot/color	5	5	5	V
Operating and storage temperature range				-25°C to $+85^\circ\text{C}$
Soldering time at 260°C ($1/16$ inch below seating plane)				3 sec

MODEL NUMBERS

PART NO.			DESCRIPTION	PACKAGE DIMENSION	INTERNAL CIRCUIT DIAGRAM
YELLOW	HER	GREEN			
GMC2885C	GMC2985C	GMC2485C	Anode column, cathode row	A	A
GMA2885C	GMA2985C	GMA2485C	Cathode column, anode row	A	B
		GMA2685C	Cathode column, anode row	B	C

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2485C

PARAMETER	TEST	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity			3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength			565		nm	$I_F = 20\text{ mA}$
Spectral line half-width			30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot			2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot				100	μA	$V_R = 5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)

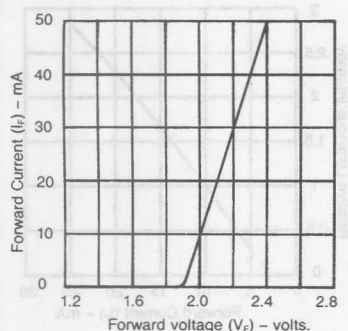


Fig. 1. Forward Current vs. Forward Voltage

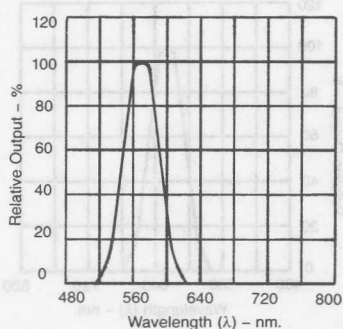


Fig. 2. Spectral Response

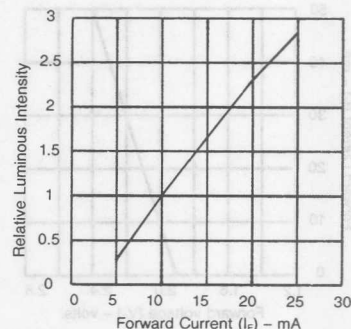


Fig. 3. Relative Luminous Intensity vs. Forward Current

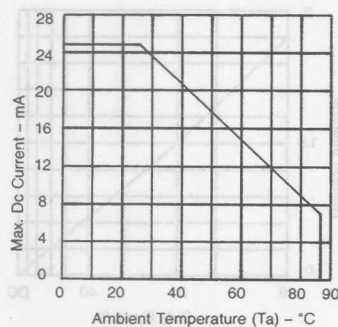


Fig. 4. Maximum Allowable DC Current Per Segment vs. Ambient Temperature

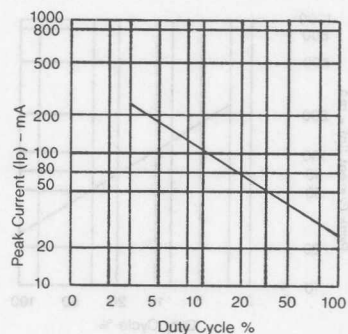


Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)

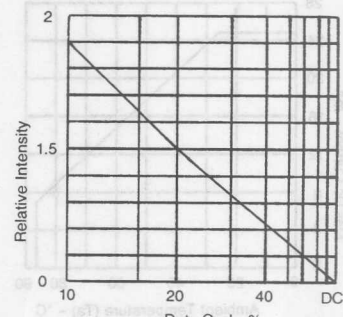


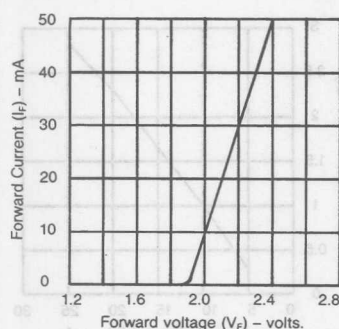
Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I = 10\text{ mA Per Seg.}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2985C

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		635		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

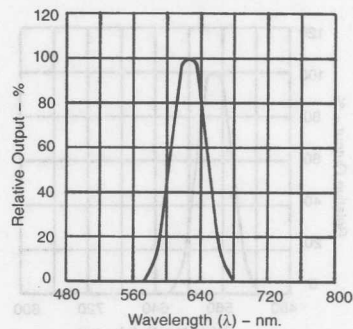
TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless otherwise specified)



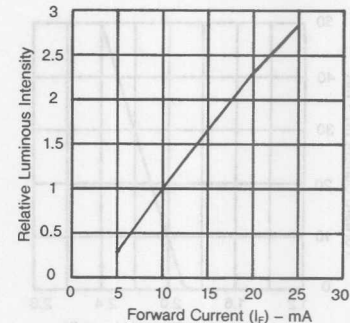
C3031

Fig. 1. Forward Current vs. Forward Voltage



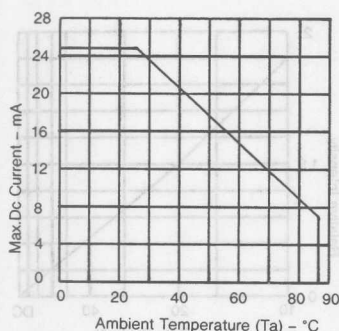
C3032

Fig. 2. Spectral Response



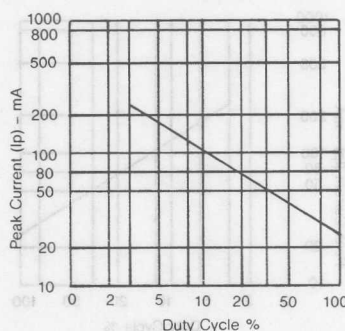
C3033

Fig. 3. Relative Luminous Intensity vs. Forward Current



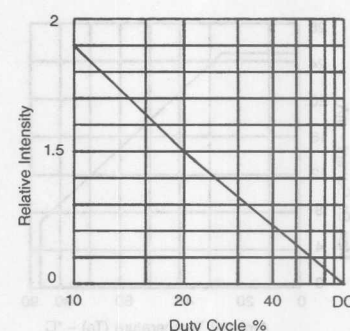
C3034

Fig. 4. Maximum Allowable DC Current Per Segment vs. Ambient Temperature



C3035

Fig. 5. Max. Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)



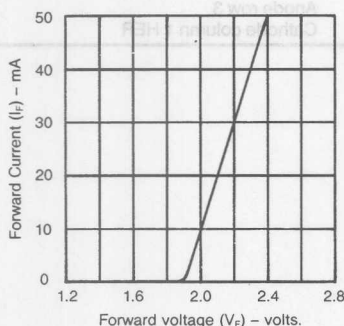
C3036

Fig. 6. Luminous Intensity vs. Duty Cycle %

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2885C

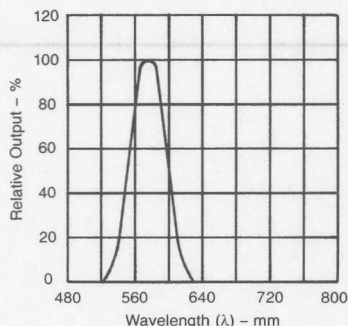
PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		585		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1	2.8	V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES
($T_A = 25^\circ\text{C}$ Unless otherwise specified)



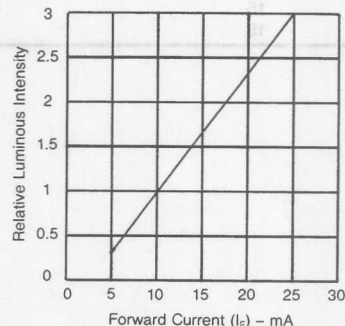
C3037

Fig. 1. Forward Current vs. Forward Voltage



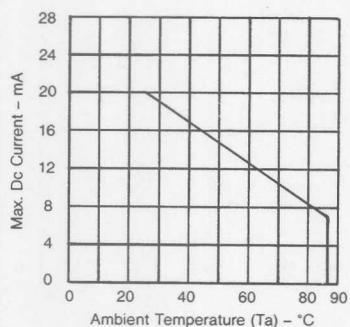
C3038

Fig. 2. Spectral Response



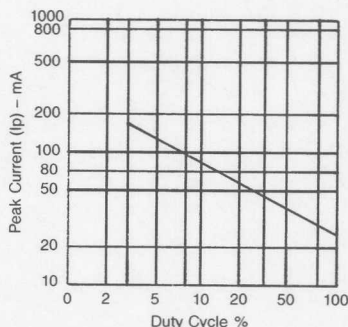
C3039

Fig. 3. Relative Luminous Intensity vs. Forward Current



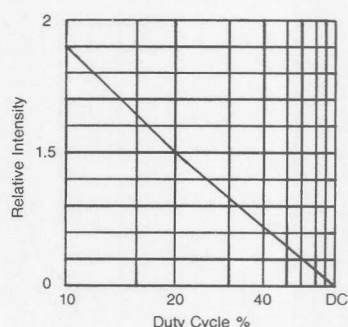
C3040

Fig. 4. Maximum Allowable DC Current Per Segment vs. Ambient Temperature



C3041

Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)



C3042

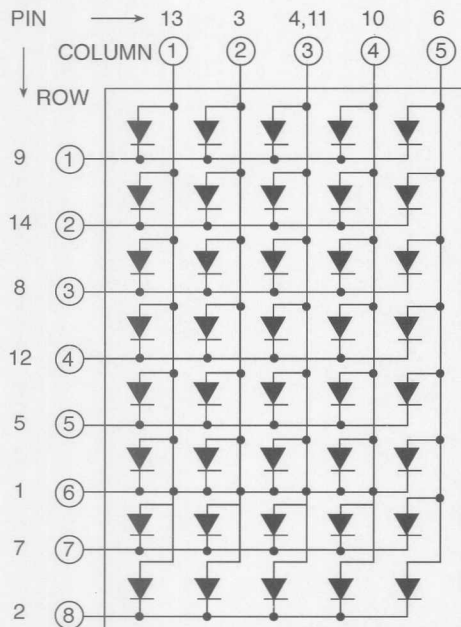
Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I = 10\text{ mA Per Seg.}$)

PIN CONNECTION

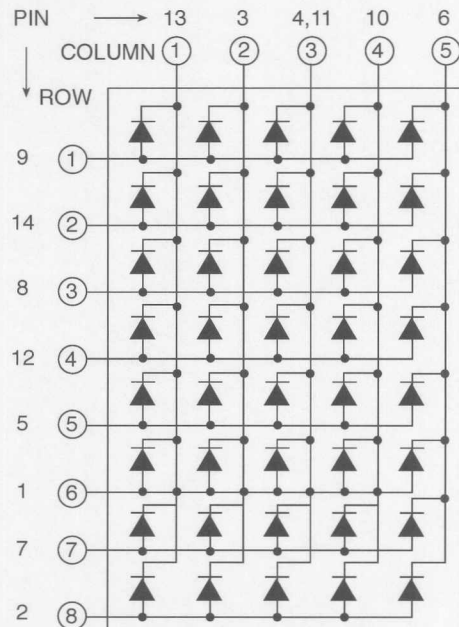
PIN NO.	GMC2X85C	GMA2X85C	GMC2685C
1	Cathode row 6	Anode row 6	Cathode column 1 green
2	Cathode row 8	Anode row 8	Cathode column 2 green
3	Anode column 2	Cathode column 2	Cathode column 2 HER
4	Anode column 3	Cathode column 3	Cathode column 3 HER
5	Cathode row 5	Anode row 5	Anode row 6
6	Anode column 5	Cathode column 5	Anode row 7
7	Cathode row 7	Anode row 7	Cathode column 4 HER
8	Cathode row 3	Anode row 3	Anode row 5
9	Cathode row 1	Anode row 1	Anode row 8
10	Anode column 4	Cathode column 4	Cathode column 5 green
11	Anode column 3	Cathode column 3	Cathode column 5 HER
12	Cathode row 4	Anode row 4	Cathode column 4 green
13	Anode column 1	Cathode column 1	Anode column 3 green
14	Cathode row 2	Anode row 2	Anode row 4
15			Anode row 2
15			Anode row 1
15			Anode row 3
15			Cathode column 1 HER

INTERNAL CIRCUIT DIAGRAM

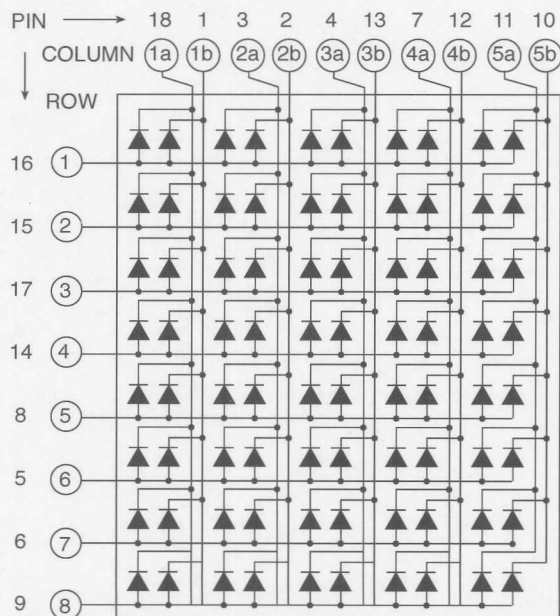
A. GMC2X85C

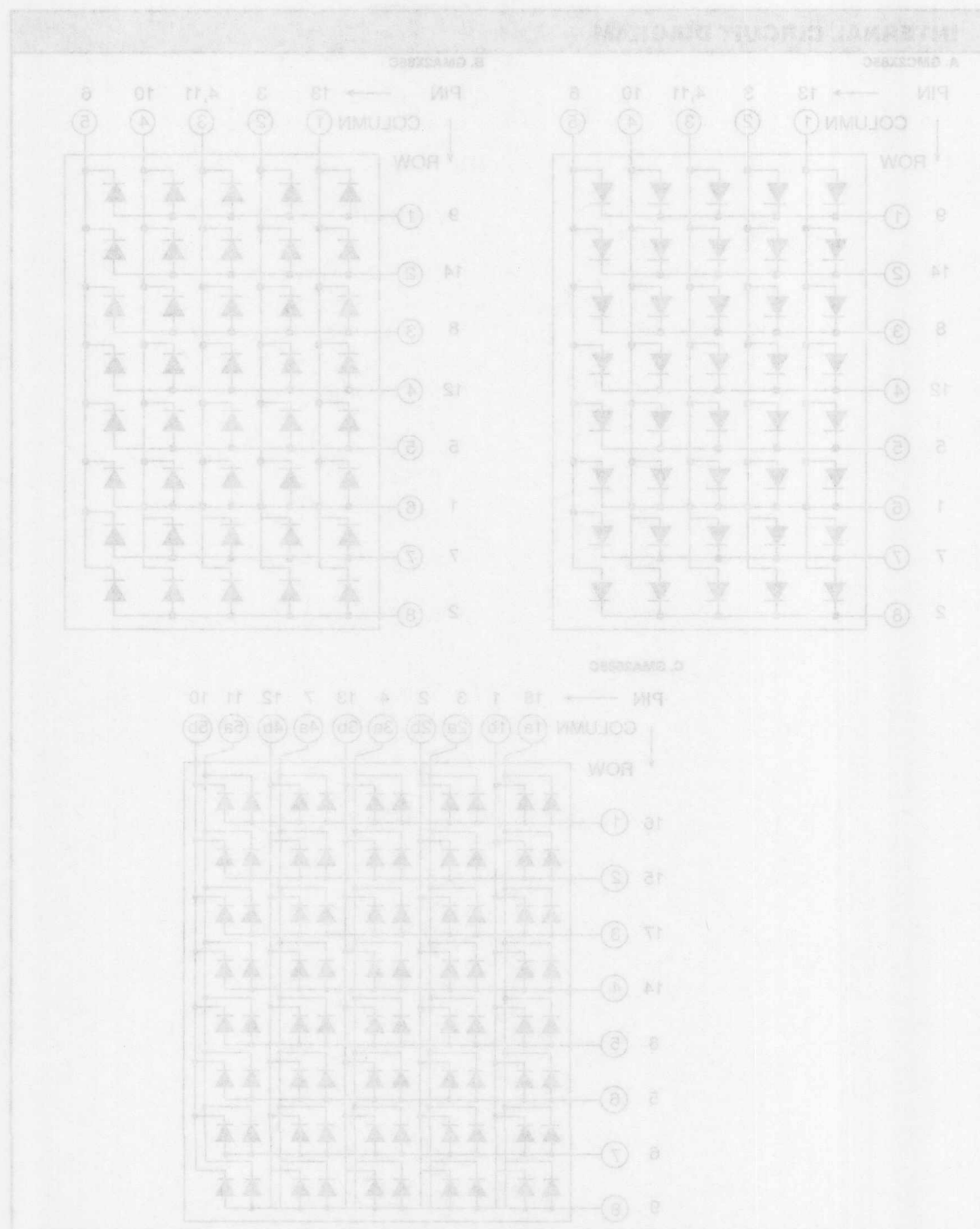


B. GMA2X85C



C. GMA2685C

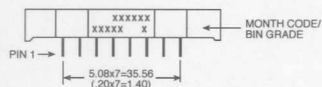
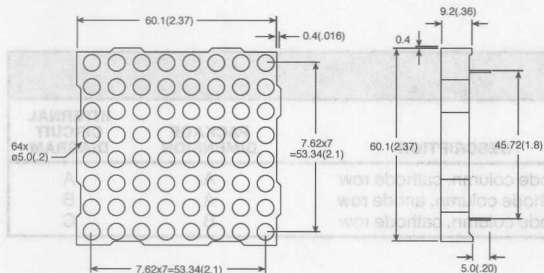




YELLOW GMA 2888C GMC 2888C
HER GMA 2988C GMC 2988C
GREEN GMA 2488C GMC 2488C
BICOLOR RED/GREEN GMC 2688C

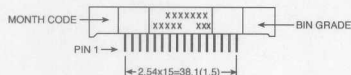
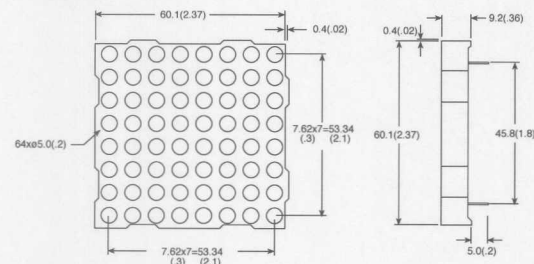
PACKAGE DIMENSIONS

A. GMX2X88C



ST2613

B. GMC2688C



ST2614

DESCRIPTION

These are 8×8 dot matrix displays with large emitting area (0.2" diameter) LED sources. The GMX2X88C series are single color displays with the exception of GMC2688C, a bicolor of red/green displays.

All displays have gray face and white dot color. Other face or dot colors are available with minimum requirement.

The X in GMX denotes row anode or row cathode.

FEATURES

- 2.3" (58.4mm) character height
- Low power requirement
- High contrast & brightness
- Wide viewing angle 130°
- 8×8 array with X-Y select
- Compatible with USASCII and EBCDIC codes
- X-Y stackable
- Choice of two matrix orientation anode or cathode column
- Easy mounting on PCB
- Categorized for luminous intensity
- Single color displays have the choice of 3 bright color — yellow/orange/green
- Multicolor color displays are applicable to 3 bright color—greens, orange (HER) and yellow (green and HER mixed)

NOTES:

1. ALL PINS ARE 0.02.
2. DIMENSIONS IN MILLIMETERS (INCH), TOLERANCE IS ±0.25 (.01) UNLESS OTHERWISE NOTED.

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ unless otherwise specified)

	YELLOW	HER	GREEN	UNITS
Power dissipation per dot/color	60	70	75	mW
Peak forward current per dot/color (duty cycle 1/10, 10KHz)	80	100	100	mA
Continuous I_F per dot/color	20	25	25	mA
Reverse voltage V_R per dot/color	5	5	5	V
Operating and storage temperature range	-25°C to $+85^\circ\text{C}$			
Soldering time at 260°C (1/16 inch below seating plane)	3 sec			

MODEL NUMBERS

PART NO.				DESCRIPTION	PACKAGE DIMENSION	INTERNAL CIRCUIT DIAGRAM
YELLOW	HER	GREEN	MULTI-COLOR			
GMC2888C	GMC2988C	GMC2488C		Anode column, cathode row	A	A
GMA2888C	GMA2988C	GMA2488C		Cathode column, anode row	A	B
			GMC2688C	Anode column, cathode row	B	C

GMA 2X88C GMC 2X88C

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless otherwise specified)
GMX 2888C

PARAMETER	TEST	UNITS	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		μcd		3000			$I_F=20\text{ mA}$
Peak emission wavelength		nm		585			$I_F=20\text{ mA}$
Spectral line half-width		nm		35			$I_F=20\text{ mA}$
Forward voltage, any dot		V		2.1	2.8		$I_F=20\text{ mA}$
Reverse voltage, any dot		μA			100		$V_R=5\text{V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES
($T_A=25^\circ\text{C}$ Unless otherwise specified)

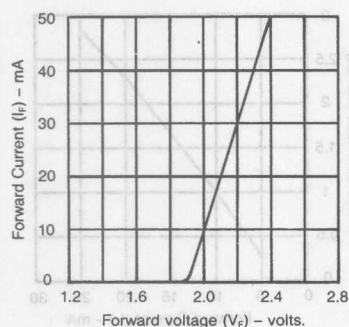


Fig. 1. Forward Current vs. Forward Voltage

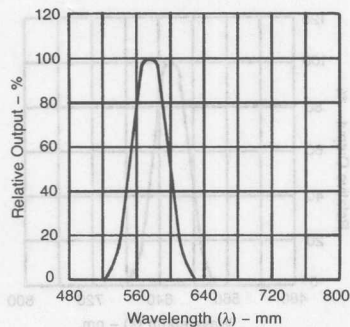


Fig. 2. Spectral Response

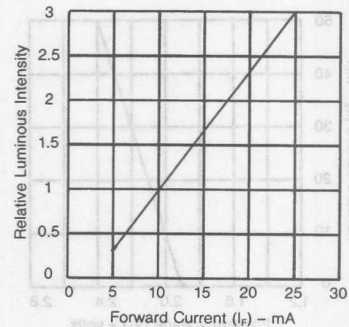


Fig. 3. Relative Luminous Intensity vs. Forward Current

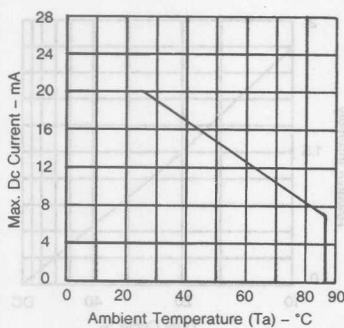


Fig. 4. Maximum Allowable DC Current Per Segment vs. A Function of Ambient Temperature

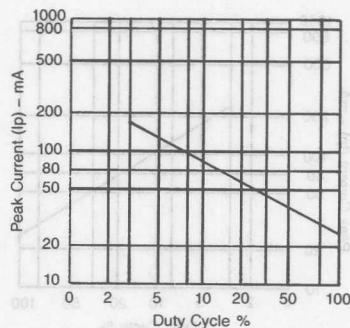


Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f=1\text{ KHz}$)

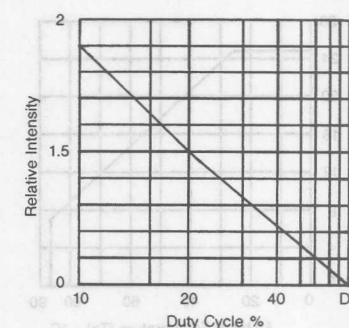


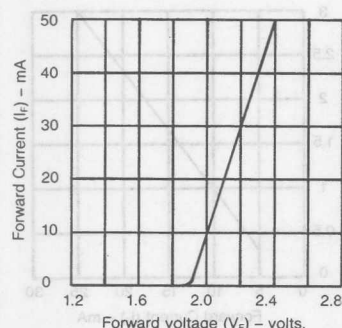
Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I=10\text{ mA Per Seg.}$)

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless otherwise specified)
GMX 2988C

PARAMETER	UNIT	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity	μcd		3000			$I_F=20\text{ mA}$
Peak emission wavelength	nm		635			$I_F=20\text{ mA}$
Spectral line half-width	nm		40			$I_F=20\text{ mA}$
Forward voltage, any dot	V		2.1	2.8		$I_F=20\text{ mA}$
Reverse voltage, any dot	V			100	μA	$V_R=5\text{ V}$

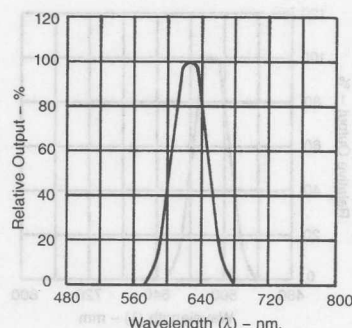
TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES

($T_A=25^\circ\text{C}$ Unless otherwise specified)



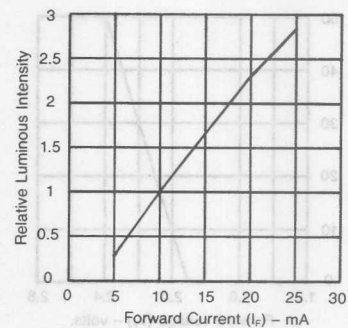
C3031

Fig. 1. Forward Current vs. Forward Voltage



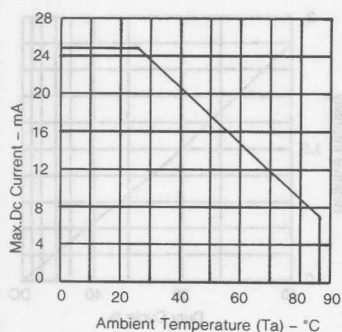
C3032

Fig. 2. Spectral Response



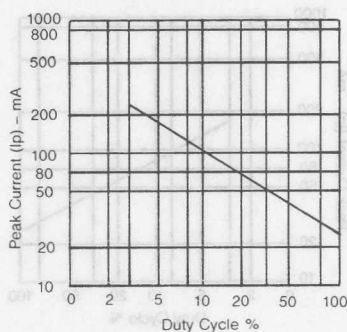
C3033

Fig. 3. Relative Luminous Intensity vs. Forward Current



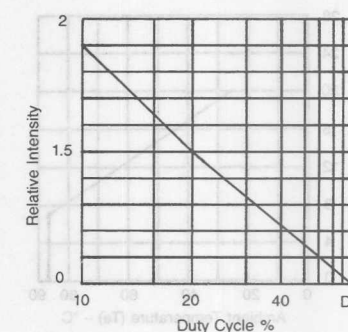
C3034

Fig. 4. Maximum Allowable DC Current Per Segment vs. A Function of Ambient Temperature



C3035

Fig. 5. Max. Peak Current vs. Duty Cycle % (Refresh Rate $F=1\text{ KHz}$)



C3036

Fig. 6. Luminous Intensity vs. Duty Cycle

ELECTRICAL/OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless otherwise specified)
GMX 2488C

PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
Average luminous intensity		3000		μcd	$I_F = 20\text{ mA}$
Peak emission wavelength		565		nm	$I_F = 20\text{ mA}$
Spectral line half-width		30		nm	$I_F = 20\text{ mA}$
Forward voltage, any dot		2.1		V	$I_F = 20\text{ mA}$
Reverse voltage, any dot			100	μA	$V_R = 5\text{ V}$

TYPICAL ELECTRICAL/OPTICAL CHARACTERISTIC CURVES
($T_A = 25^\circ\text{C}$ Unless otherwise specified)

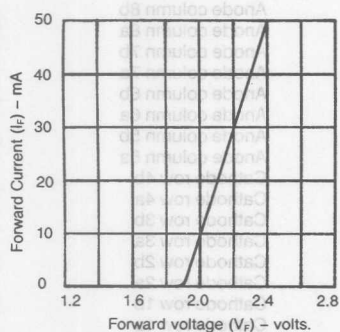


Fig. 1. Forward Current vs. Forward Voltage

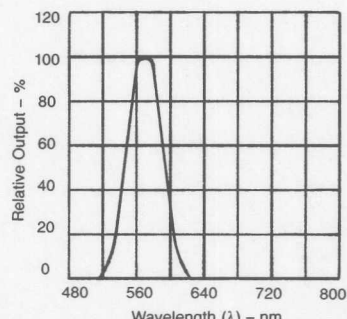


Fig. 2. Spectral Response

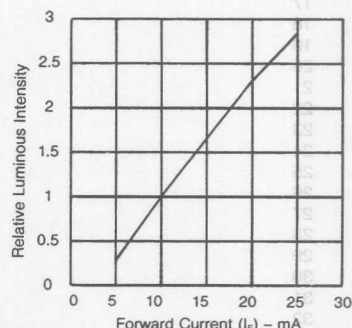


Fig. 3. Relative Luminous Intensity vs. Forward Current

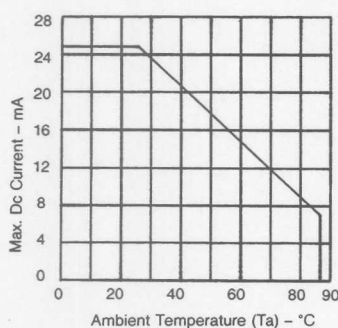


Fig. 4. Maximum Allowable DC Current Per Segment vs. A Function of Ambient Temperature

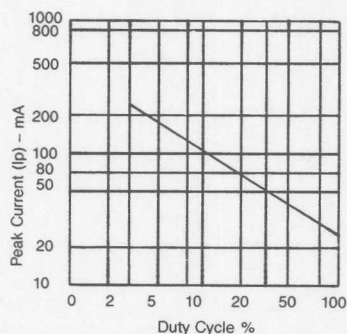


Fig. 5. Max Peak Current vs. Duty Cycle % (Refresh Rate $f = 1\text{ KHz}$)

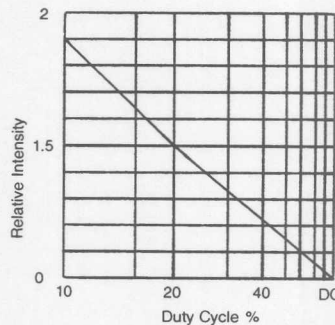
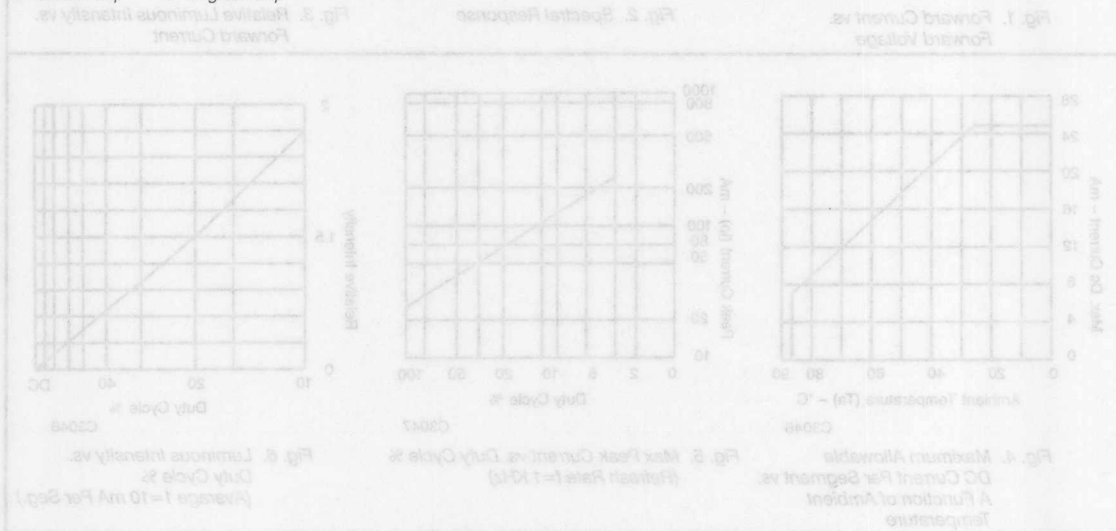


Fig. 6. Luminous Intensity vs. Duty Cycle % (Average $I = 10\text{ mA}$ Per Seg.)

PIN CONNECTION

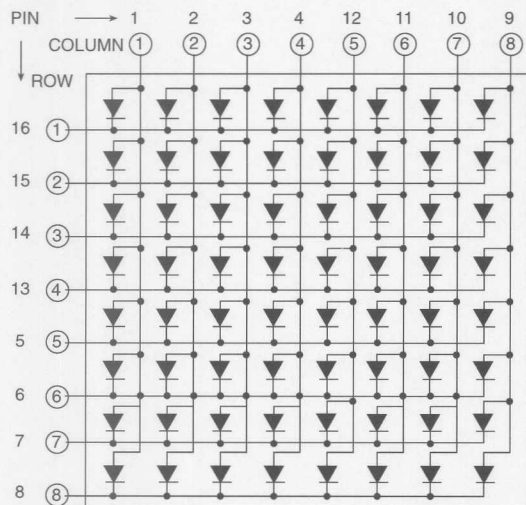
PIN NO.	GMC2X88C	GMA2X88C	GMC2688C
1	Anode column 1	Cathode column 1	Anode Column 1b
2	Anode column 2	Cathode column 2	Anode column 1a
3	Anode column 3	Cathode column 3	Anode column 2b
4	Anode column 4	Cathode column 4	Anode column 2a
5	Cathode row 5	Anode row 5	Anode column 3b
6	Cathode row 6	Anode row 6	Anode column 3a
7	Cathode row 7	Anode row 7	Anode column 4b
8	Cathode row 8	Anode row 8	Anode column 4a
9	Anode column 8	Cathode column 8	Cathode row 5b
10	Anode column 7	Cathode column 7	Cathode row 5a
11	Anode column 6	Cathode column 6	Cathode row 6b
12	Anode column 5	Cathode column 5	Cathode row 6a
13	Cathode row 4	Anode row 4	Cathode row 7b
14	Cathode row 3	Anode row 3	Cathode row 7a
15	Cathode row 2	Anode row 2	Cathode row 8b
16	Cathode row 1	Anode row 1	Cathode row 8a
17			Anode column 8b
18			Anode column 8a
19			Anode column 7b
20			Anode column 7a
21			Anode column 6b
22			Anode column 6a
23			Anode column 5b
24			Anode column 5a
25			Cathode row 4b
26			Cathode row 4a
27			Cathode row 3b
28			Cathode row 3a
29			Cathode row 2b
30			Cathode row 2a
31			Cathode row 1b
32			Cathode row 1a

"a" for HER chip "b" for green chip

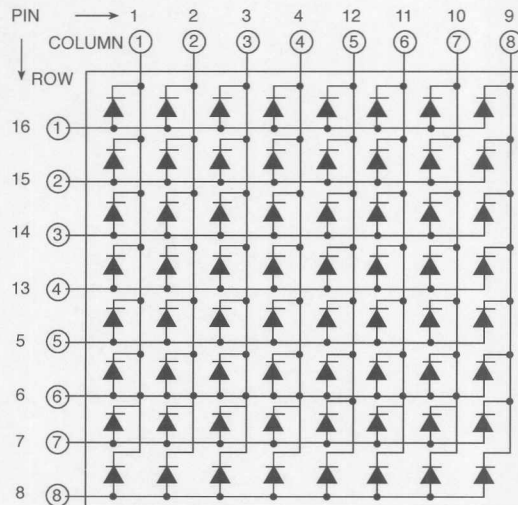


INTERNAL CIRCUIT DIAGRAM

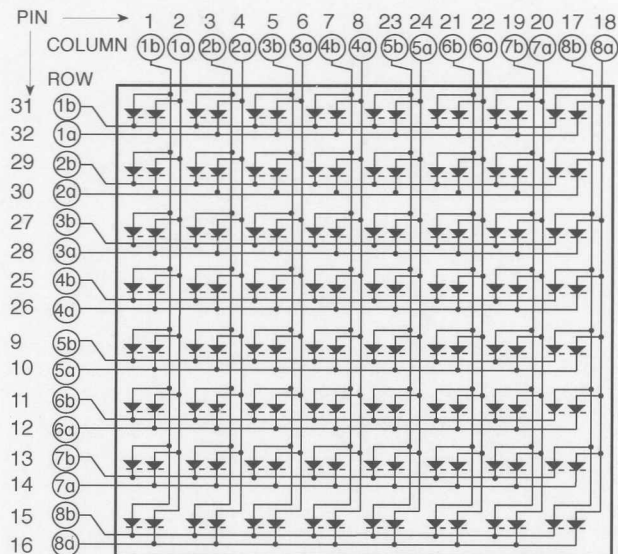
A. GMC2X88C

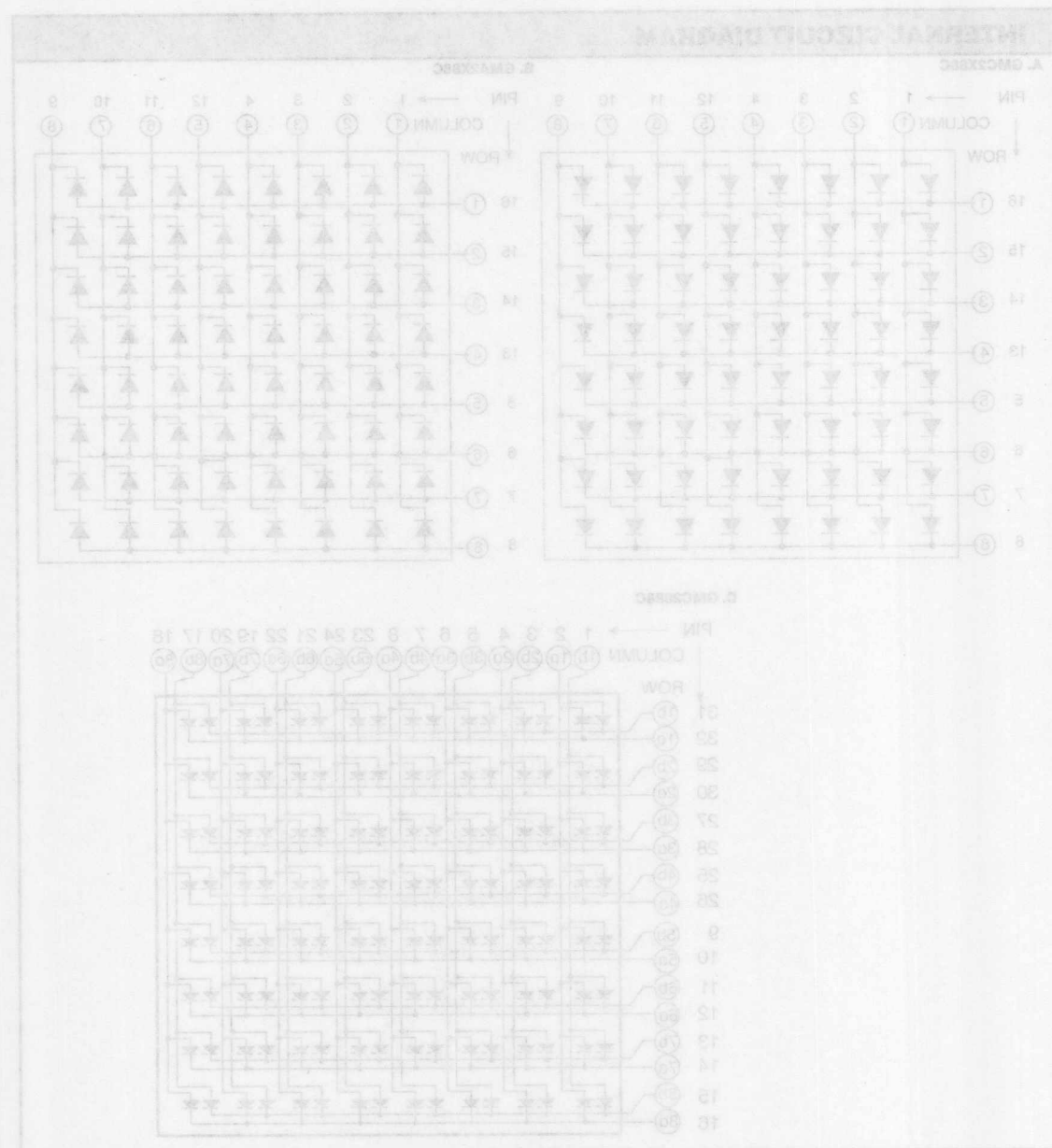


B. GMA2X88C



C. GMC2688C

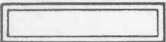
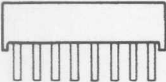
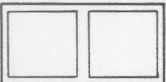
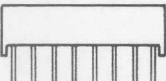
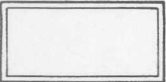
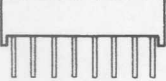


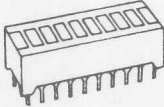


LIGHT BARS & BARGRAPH ARRAYS

Alphanumeric Product Listing

		Product	Package	
		HLMP-2300	5-5	
		HLMP-2350	5-5	
		HLMP-2400	5-5	
		HLMP-2450	5-5	
		HLMP-2500	5-5	
		HLMP-2550	5-5	
		HLMP-2655	5-5	
		HLMP-2670	5-5	
		HLMP-2685	5-5	
		HLMP-2755	5-5	
		HLMP-2770	5-5	
		HLMP-2785	5-5	
		HLMP-2855	5-5	
		HLMP-2870	5-5	
		HLMP-2885	5-5	
		MV53164	5-15	
		MV53173	5-11	
		MV54164	5-15	
		MV54173	5-11	
		MV57164	5-15	
		MV57173	5-11	
		MV5A164	5-19	
		MV5B164	5-19	
		MV5C164	5-19	
		MV5D164	5-19	
		MV5E164	5-19	

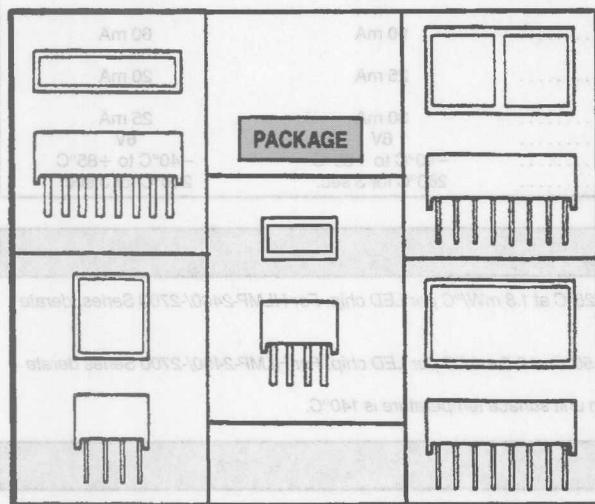
PACKAGE	PART NUMBER	DESCRIPTION			TYPICAL LUMINOUS INTENSITY @ 20 mA	TYPICAL FORWARD VOLTAGE @ 20 mA	PAGE
		COLOR	PACKAGE	LENS			
 	HLMP-2300	Hi. Eff. Red	4 Pin In-Line; .100" Centers; .400"L x .195"W x .240"H (0.350" x 0.150" Emitting Area)	Diff.	23 mcd	2.0 V	5-5
	HLMP-2400	Yellow		Diff.	20 mcd	2.1 V	
	HLMP-2500	Green		Green Diff.	25 mcd	2.2 V	
 	HLMP-2350	Hi. Eff. Red	8 Pin DIP; .100" Centers; .800"L x .195"W x .240"H (0.750" x 0.150" Emitting Area)	Diff.	45 mcd	2.0 V	5-5
	HLMP-2450	Yellow		Diff.	38 mcd	2.1 V	
	HLMP-2550	Green		Green Diff.	50 mcd	2.2 V	
 	HLMP-2655	Hi. Eff. Red	8 Pin DIP; .100" Centers; .400"L x .400"W x .240"H Square Arrangement (0.350" x 0.150" Emitting Area)	Diff.	43 mcd	2.0 V	5-5
	HLMP-2755	Yellow		Diff.	35 mcd	2.1 V	
	HLMP-2855	Green		Green Diff.	50 mcd	2.2 V	
 	HLMP-2670	Hi. Eff. Red	16 Pin DIP; .100" Centers; .800"L x .400"W x .240"H Dual Square Arrangement	Diff.	45 mcd	2.0 V	5-5
	HLMP-2770	Yellow		Diff.	35 mcd	2.1 V	
	HLMP-2870	Green		Green Diff.	50 mcd	2.2 V	
 	HLMP-2685	Hi. Eff. Red	16 Pin DIP; .100" Centers; .800"L x .400"W x .240"H Single Bar Arrangement (0.350" x 0.700" Emitting Area)	Diff.	80 mcd	2.0 V	5-5
	HLMP-2785	Yellow		Diff.	70 mcd	2.1 V	
	HLMP-2885	Green		Green Diff.	100 mcd	2.2V	

PACKAGE	PART NUMBER	SOURCE COLOR	SEGMENT/ FACE COLOR	I _v TYP. mcd/mA	2θ _{1/2}	PAGE
10 Element 	MV53164	Yellow	Untinted Diff./Grey			
	MV54164	Hi. Eff. Green	Untinted Diff./Grey	1.0/10	130	5-15
	MV57164	Hi. Eff. Red	Red Diff./Grey			
	MV5A164	R,R,R,Y,Y,Y,G,G,G	Untinted Diff./Grey	1.0/10	130	5-19
	MV5B164	R,R,Y,Y,G,G,Y,Y,R,R				
	MV5C164	G,G,G,G,G,G,Y,Y,Y,R				
	MV5D164	G,G,G,G,G,R,R,R,R,Y				
	MV5E164	G,Y,Y,Y,Y,Y,R,R,R				
.5-Inch Rectangular 	MV53173	Yellow	Yellow Diff.			
	MV54173	Hi. Eff. Green	Untinted Diff.	1.0/20	130	5-11
	MV57173	Hi. Eff. Red	Red Diff.			

BARGRAPHS AND PANEL INDICATORS

PACKAGE	PART NUMBER	SOURCE COLOR	SEGMENT/ FACE COLOR	L TYP. (mm/inch)	20	PAGE
 10 Element	MV23164	Yellow	Unlit Diff. Grey		130	5-15
	MV24164	Hi. Eff. Green	Unlit Diff. Grey	1.0/10		
	MV27164	Hi. Eff. Red	Red Diff. Grey			
	MV2A164	R,R,Y,Y,G,G,G	Unlit Diff. Grey	1.0/10	130	5-19
	MV2B164	R,R,Y,G,G,Y,Y,R				
	MV2C164	G,G,G,G,G,Y,Y,R				
	MV2D164	G,G,G,G,R,R,R,Y				
	MV2E164	G,Y,Y,Y,Y,R,R,R				
 3-inch Rectangular	MV23173	Yellow	Yellow Diff.		130	5-11
	MV24173	Hi. Eff. Green	Unlit Diff.	1.0/10		
	MV27173	Hi. Eff. Red	Red Diff.			

HIGH EFFICIENCY RED HLMP-2300/2600 SERIES
YELLOW HLMP-2400/2700 SERIES
HIGH EFFICIENCY GREEN HLMP-2500/2800 SERIES



DESCRIPTION

These LED Light Bar series are bright, large emitting area, rectangular devices that are designed for backlighting legend/message annunciators.

These devices are offered in single-in-line and dual-in-line packages that contain single or segmented light-emitting area. Each package style is offered in High Efficiency Red, Yellow, or Green emission color.

FEATURES

- Large area, uniform, bright light-emitting surfaces
- Select from six package styles
- Choice of three colors
- Categorized for intensity and color
- X-Y stackable
- Easily driven with I.C.s
- Alternate source for popular backlighting components

MODEL NUMBERS

PART NO.	COLOR	DESCRIPTION	PACKAGE	PIN OUT
HLMP-2300	High Efficiency Red	2 LED Single-in-line		
HLMP-2400	Yellow	0.35 in. x 0.15 in. Area	A	A
HLMP-2500	High Efficiency Green			
HLMP-2350	High Efficiency Red	4 LED Single-in-line		
HLMP-2450	Yellow	0.75 in. x 0.15 in. Area	B	B
HLMP-2550	High Efficiency Green			
HLMP-2655	High Efficiency Red	4 LED Dual-in-line		
HLMP-2755	Yellow	0.35 in. x 0.35 in. Area	C	C
HLMP-2855	High Efficiency Green			
HLMP-2670	High Efficiency Red	Dual 0.35 in. x 0.35 in. Area		
HLMP-2770	Yellow	Dual-in-line package	D	D
HLMP-2870	High Efficiency Green			
HLMP-2685	High Efficiency Red	8 LED 0.35 in. x 0.75 in. Area		
HLMP-2785	Yellow	Dual-in-line package	E	D
HLMP-2885	High Efficiency Green			

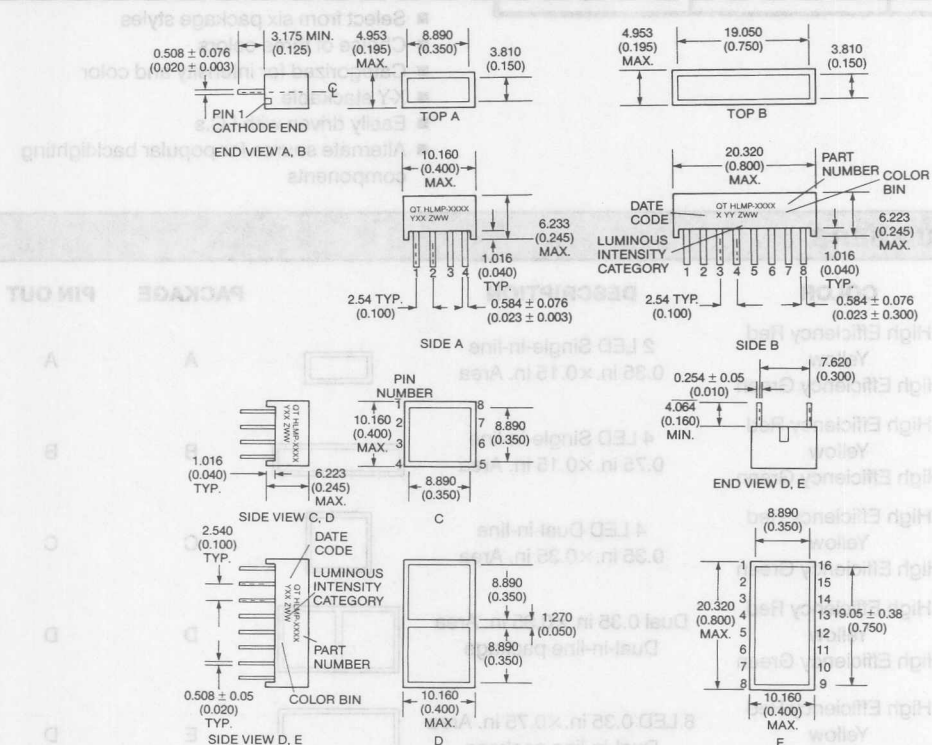
ABSOLUTE MAXIMUM RATINGS $T_A=25^\circ\text{C}$ (Unless Otherwise Stated)

	HIGH EFFICIENCY RED HIGH EFFICIENCY GREEN HLMP-2300/-2500 -2600/-2800 SERIES	YELLOW HLMP-2400/ -2700 SERIES
Power dissipation per LED chip (See Note 1)	135 mW	85 mW
Peak forward current per LED chip, $T_A=50^\circ\text{C}$ (max. pulse width=2 ms) (See Notes 1 and 2)	90 mA	60 mA
Average forward current per LED chip pulsed conditions, $T_A=50^\circ\text{C}$ (See Note 2)	25 mA	20 mA
DC forward current per LED chip, $T_A=50^\circ\text{C}$ (See Note 3)	30 mA	25 mA
Reverse voltage per LED chip	6V	6V
Storage and operating temperature range	-40°C to $+85^\circ\text{C}$	-40°C to $+85^\circ\text{C}$
Soldering time at 260°C (See Note 4)	260°C for 3 sec.	260°C for 3 sec.

NOTES

1. For HLMP-2300/-2500/-2600/-2800 Series, derate above $T_A=25^\circ\text{C}$ at $1.8\text{ mW}/^\circ\text{C}$ per LED chip. For HLMP-2400/-2700 Series, derate above $T_A=50^\circ\text{C}$ at $1.8\text{ mW}/^\circ\text{C}$ per LED chip.
2. See Figure 1/2 to establish pulse operating conditions.
3. For HLMP-2300/-2500/-2600/-2800 Series, derate above $T_A=50^\circ\text{C}$ at $0.5\text{ mA}/^\circ\text{C}$ per LED chip. For HLMP-2400/-2700 Series derate above $T_A=60^\circ\text{C}$ at $9.5\text{ mA}/^\circ\text{C}$ per LED chip.
4. Lead immersed to 1/16 in. from body of the device. Maximum unit surface temperature is 140°C .

PACKAGE DIMENSIONS



NOTE: DIMENSIONS IN MILLIMETERS (INCHES). TOLERANCES ± 0.25 (± 0.010) UNLESS OTHERWISE INDICATED

C2015

ELECTRO-OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$)
HIGH EFFICIENCY RED

PARAMETER	SYMBOL	HLMP					UNIT	TEST CONDITIONS
		-2300	-2350	-2655	-2670	-2685		
Luminous Intensity	min. I_V	6.0	13	13	13	22	mcd	$I_F=20\text{ mA}$
	typ.	23	45	43	45	80	mcd	$I_F=20\text{ mA}$
	max.	30	50	50	50	100	mcd	$I_F=60\text{ mA pK, 1:3 D.F.}$
Forward voltage	max. V_F	2.6	2.6	2.6	2.6	2.6	V	$I_F=20\text{ mA}$
	typ.	2.0	2.0	2.0	2.0	2.0	V	
Peak wavelength	typ. λ_p	630	630	630	630	630	nm	
Dominant wavelength	typ. λ_d	626	626	626	626	626	nm	
Capacitance	typ. C	45	45	45	45	45	pF	$V_F=0, f=1\text{ MHz}$
Reverse voltage	min. V_R	6	6	6	6	6	V	$I_R=100\text{ }\mu\text{A}$
Thermal resistance	typ. θ_{JL}	150	150	150	150	150	$^\circ\text{C/W/LED chip}$	

ELECTRO-OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$)
YELLOW

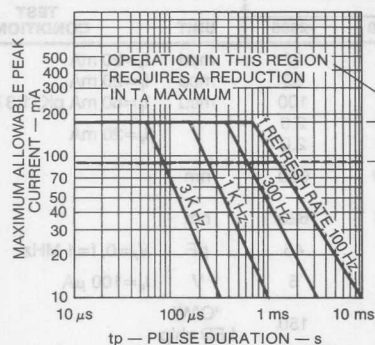
PARAMETER	SYMBOL	HLMP					UNIT	TEST CONDITIONS
		-2400	-2450	-2755	-2770	-2785		
Luminous Intensity	min. I_V	6	13	13	13	26	mcd	$I_F=20\text{ mA}$
	typ.	20	38	35	35	70	mcd	$I_F=20\text{ mA}$
	max.	33	60	60	60	115	mcd	$I_F=60\text{ mA pK, 1:3 D.F.}$
Forward voltage	max. V_F	2.6	2.6	2.6	2.6	2.6	V	$I_F=20\text{ mA}$
	typ.	2.1	2.1	2.1	2.1	2.1	V	
Peak wavelength	typ. λ_p	585	585	585	585	585	nm	
Dominant wavelength	typ. λ_d	588	588	588	588	588	nm	
Capacitance	typ. C	35	35	35	35	35	pF	$V_F=0, f=1\text{ MHz}$
Reverse voltage	min. V_R	6	6	6	6	6	V	$I_R=100\text{ }\mu\text{A}$
Thermal resistance	typ. θ_{JL}	150	150	150	150	150	$^\circ\text{C/W/LED chip}$	

ELECTRO-OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$)
HIGH EFFICIENCY GREEN

PARAMETER	SYMBOL	HLMP					UNIT	TEST CONDITIONS
		-2500	-2550	-2855	-2870	-2885		
Luminous Intensity	min. I_V	5	11	11	11	22	mcd	$I_F=20\text{ mA}$
	typ.	25	50	50	50	100	mcd	$I_F=20\text{ mA}$
	max.	38	75	75	75	150	mcd	$I_F=60\text{ mA pK, 1:3 D.F.}$
Forward voltage	max. V_F	2.6	2.6	2.6	2.6	2.6	V	$I_F=20\text{ mA}$
	typ.	2.2	2.2	2.2	2.2	2.2	V	
Peak wavelength	typ. λ_p	565	565	565	565	565	nm	
Dominant wavelength	typ. λ_d	567	567	567	567	567	nm	
Capacitance	typ. C	40	40	40	40	40	pF	$V_F=0, f=1\text{ MHz}$
Reverse voltage	min. V_R	6	6	6	6	6	V	$I_R=100\text{ }\mu\text{A}$
Thermal resistance	typ. θ_{JL}	150	150	150	150	150	$^\circ\text{C/W/LED chip}$	

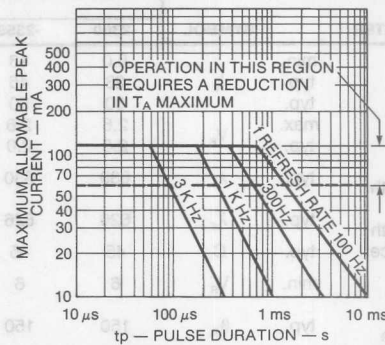
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)



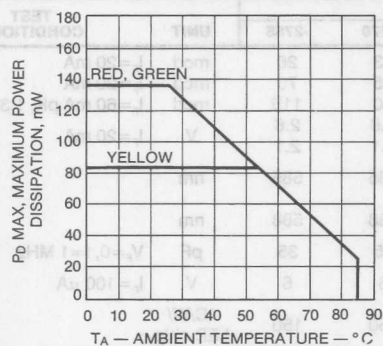
C2013

Fig. 1. Maximum Tolerable Peak Current per LED Chip vs. Pulse Duration for HLMP-23X0/-26XX/-25X0/-28XX



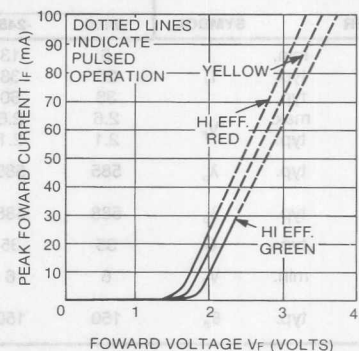
C2014

Fig. 2. Maximum Tolerable Peak Current per LED Chip vs. Pulse Duration for HLMP-24X0/-27XX Devices



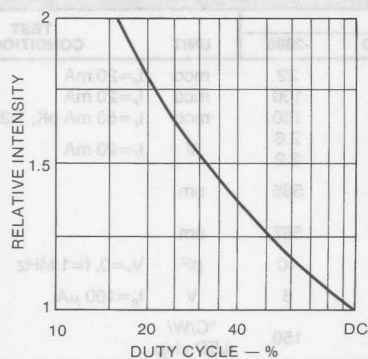
C2025

Fig. 3. Maximum Power Dissipation per LED vs. Ambient Temperature



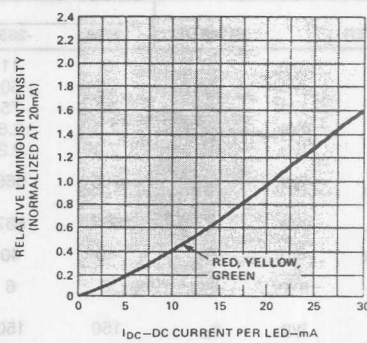
C1833A

Fig. 4. Forward Current vs. Forward Voltage



C1194C

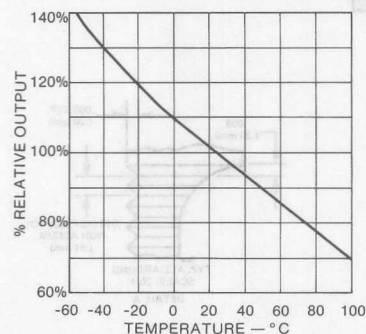
Fig. 5. Luminous Intensity vs. Duty Cycle



C3077

Fig. 6. Luminous Intensity vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)



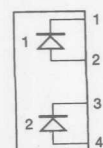
C654B

Fig. 7. Output vs. Temperature

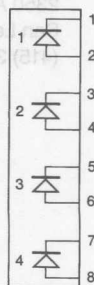
PIN CONNECTIONS TO ELECTRICAL SCHEMATIC

PIN	ELECTRICAL CONNECTION			
	HLMP-2X00	HLMP-2X50	HLMP-2X55	HLMP-2X70/-2X85
1	1 Cathode	1 Cathode	1 Cathode	1 Cathode
2	1 Anode	1 Anode	1 Anode	1 Anode
3	2 Cathode	2 Cathode	2 Anode	2 Anode
4	2 Anode	2 Anode	2 Cathode	2 Cathode
5		3 Cathode	3 Cathode	3 Cathode
6		3 Anode	3 Anode	3 Anode
7		4 Cathode	4 Anode	4 Anode
8		4 Anode	4 Cathode	4 Cathode
9				5 Cathode
10				5 Anode
11				6 Anode
12				6 Cathode
13				7 Cathode
14				7 Anode
15				8 Anode
16				8 Cathode

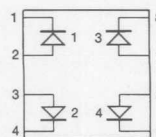
ELECTRICAL SCHEMATIC



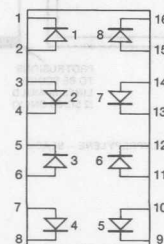
A
HLMP - 2X00



B
HLMP - 2X50



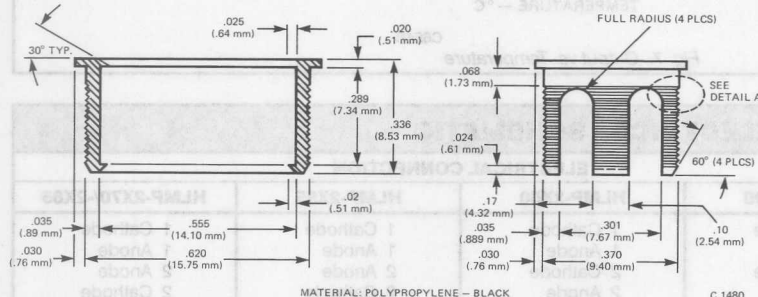
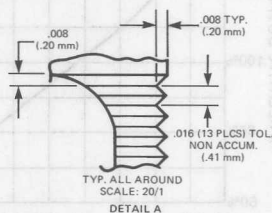
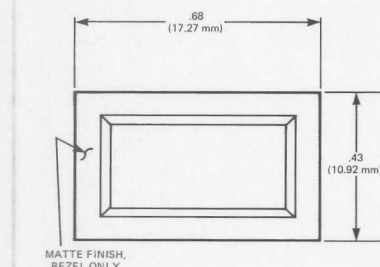
C
HLMP - 2X55



D
HLMP - 2X70

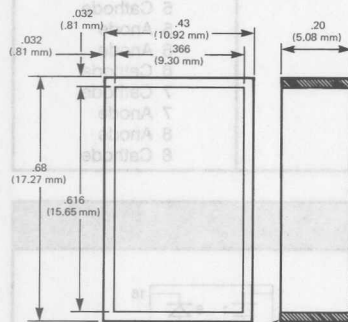
C2016

PACKAGE DIMENSIONS



MATERIAL: POLYPROPYLENE - BLACK

C 1480



PROTRUSIONS
TO BE SCORE
LINES IN MOLD
(2 SIDES ONLY)

MATERIAL: POLYPROPYLENE - BLACK

C 1481

DESCRIPTION

These MP73 mounting grommet is intended for panel mounting the MV5X173 rectangular lamp. The grommets are made of Black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP73 can be used on any panel thickness up to .125-inch (3.18 mm).

PANEL HOLE PUNCHING

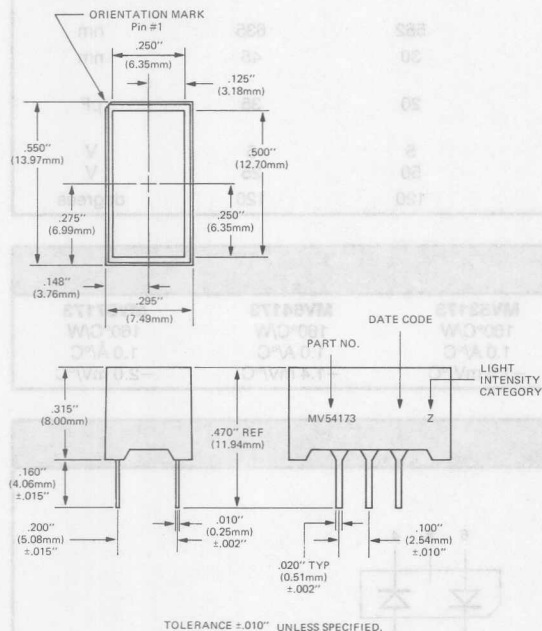
Punches may be ordered from one of the following sources:

W.A. WHITNEY COMPANY
650 Race Street
Rockford, IL 61105
(815) 964-6771

ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600

YELLOW MV53173
HIGH EFFICIENCY GREEN MV54173
HIGH EFFICIENCY RED MV57173

PACKAGE DIMENSIONS



DESCRIPTION

The MV5X173 series is a large rectangular lamp which contains two LED chips with separate anodes and cathodes for each light. The illuminated area is 0.500-inches×0.250-inches (12.7 mm×6.35 mm).

FEATURES

- .500-inch×.250-inch lighted area available in three colors
- Solid state reliability
- Fast switching—excellent for multiplexing
- Low power consumption
- Directly compatible with IC's
- Wide viewing angle
- .2 inch DIP lead spacing
- Mounting hardware available
- Categorized for Luminous Intensity (See Note 1)

APPLICATIONS

- Panel indicators
- Backlight legends
- Light arrays

ABSOLUTE MAXIMUM RATINGS

	MV53173	MV54173	MV57173
Power dissipation at 25°C	190 mW	200 mW	200 mW
Derate linearly from 50°C	-4.3 mW/°C	-4.5 mW/°C	-4.3 mW/°C
Storage temperature	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C
Operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current per light (25°C)	20 mA	30 mA	35 mA
Peak forward current per LED chip (1 μsec pulse width, 300 pps)	60 mA	90 mA	1.0 A
Lead soldering time at 260°C (See Notes 3 and 5)	5 sec.	5 sec.	5 sec.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

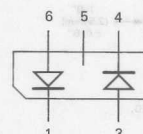
PARAMETER	TEST CONDITIONS	MV53173	MV54173	MV57173	UNITS
Forward voltage (V_F)					
Typ.	$I_F = 20 \text{ mA}$	2.0	2.2	2.0	V
Max.	$I_F = 20 \text{ mA}$	2.5	3.0	2.5	V
Luminous Intensity					
Min. (See Note 1)	$I_F = 20 \text{ mA}$	4.5	4.5	4.5	mcd
Peak wavelength					
Typ.	$I_F = 20 \text{ mA}$	585	562	635	nm
Spectral line half width	$I_F = 20 \text{ mA}$	45	30	45	nm
Capacitance					
Typ.	$V = 0, f = 1 \text{ MHz}$	35	20	35	pF
Reverse voltage (V_R)					
Min.	$I_R = 100 \mu\text{A}$	5	5	5	V
Typ.	$I_R = 100 \mu\text{A}$	25	50	25	V
Viewing angle (total)		120	120	120	degrees

TYPICAL THERMAL CHARACTERISTICS

	MV53173	MV54173	MV57173
Thermal resistance junction to free air Φ_{JA}	160°C/W	160°C/W	160°C/W
Wavelength temperature coefficient (case temp.)	1.0 Å/°C	1.0 Å/°C	1.0 Å/°C
Forward voltage temperature coefficient	-1.5 mV/°C	-1.4 mV/°C	-2.0 mV/°C

PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS
1	Cathode 1
2	No Pin
3	Anode 2
4	Cathode 2
5	NC
6	Anode 1



FILTER RECOMMENDATIONS

For optimum ON and OFF contrast, one of the following filters or equivalents may be used over the lamp:

MV53173

Panelgraphic Yellow 25 or Amber 23
Homalite 190—1720 or 100—1726

MV54173

Panelgraphic Green 48
Homalite 100—1440 Green

MV57173

Panelgraphic Red 60
Homalite 100—1605

In situations of high ambient light, a neutral density filter can be used to achieve greater contrast:

Panelgraphic Grey 10

Panelgraphic Grey 10
Homalite 100—1266 Grey

NOTES

1. The average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. The standard of measurement is the Photo Research Corp. "Spectra" Microcandela Meter (Model IV-D) corrected for wavelength. Intensity will not vary more than $\pm 33.3\%$ between all segments within a unit.
2. Leads immersed to 1/16 inch (1.6 mm) from the body of the device. Maximum unit surface temperature is 140°C.
3. All units are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.
4. For flux removal, Freon TF, Freon TE, Isoproponal or water may be used to their boiling points.

TYPICAL CURVES (Per LED Chip Unless Indicated) (25°C Free Air Temperature)

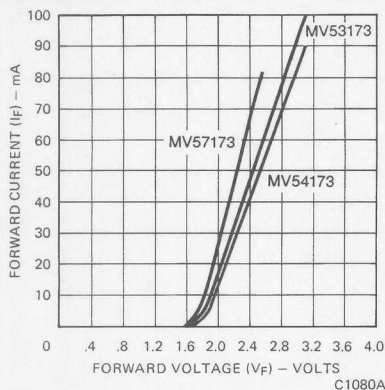


Fig. 1. Forward Current vs. Forward Voltage

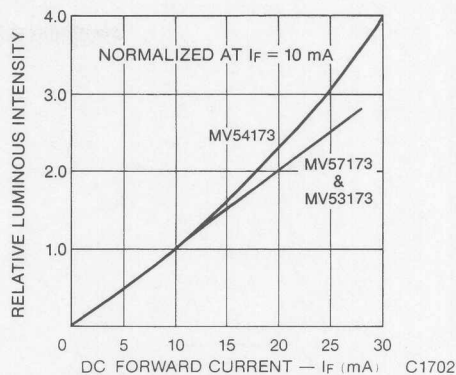


Fig. 2. Relative Luminous Intensity vs. DC Forward Current (Both LED Chips ON)

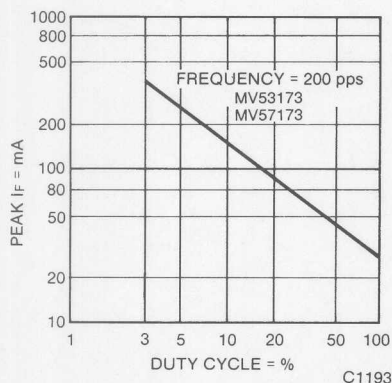


Fig. 3. Max Peak Current vs. Duty Cycle

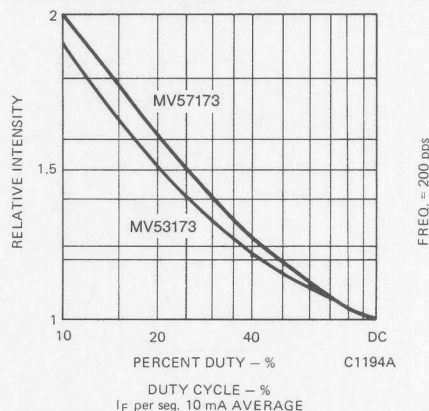


Fig. 4. Luminous Intensity vs. Duty Cycle

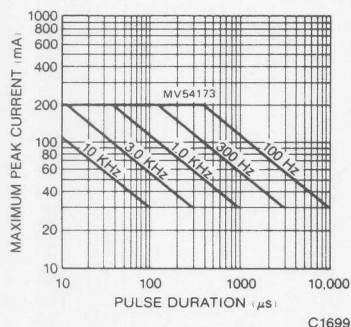


Fig. 5. Maximum Peak Current vs. Pulse Duration

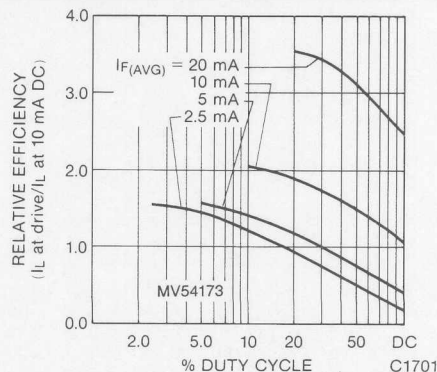


Fig. 6. Relative Efficiency vs. Duty Cycle

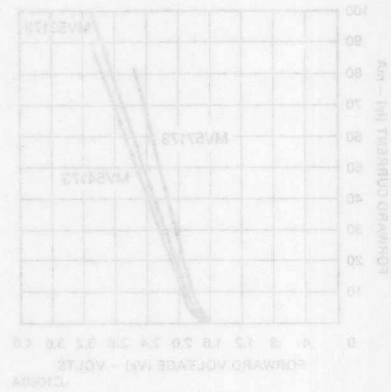


Fig. 1. Forward Current vs. Forward Voltage

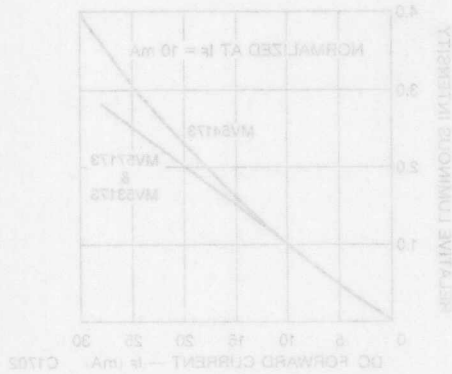


Fig. 2. Relative Luminous Intensity vs. DC Forward Current (Both LED Chips ON)

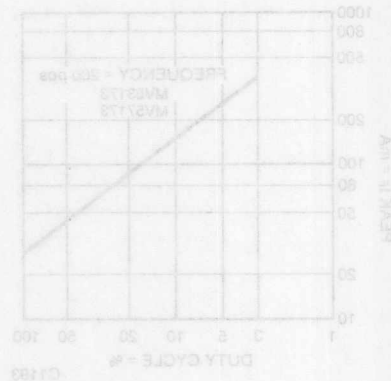


Fig. 3. Max. Peak Current vs. Duty Cycle

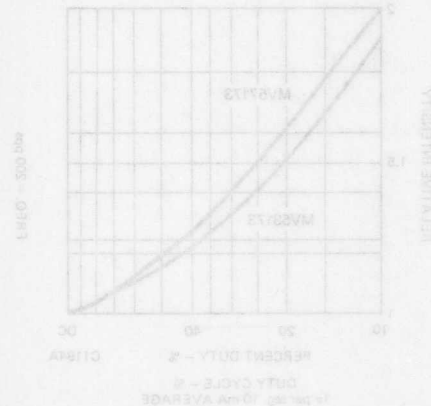


Fig. 4. Luminous Intensity vs. Duty Cycle

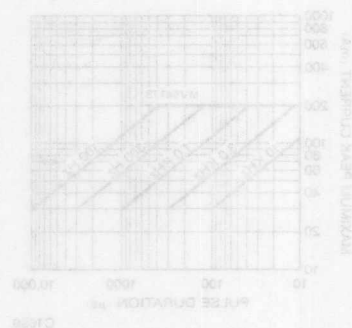


Fig. 5. Maximum Peak Current vs. Pulse Duration

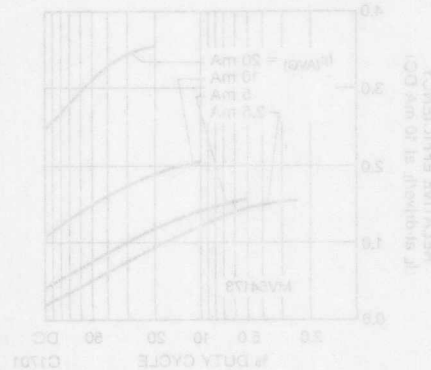
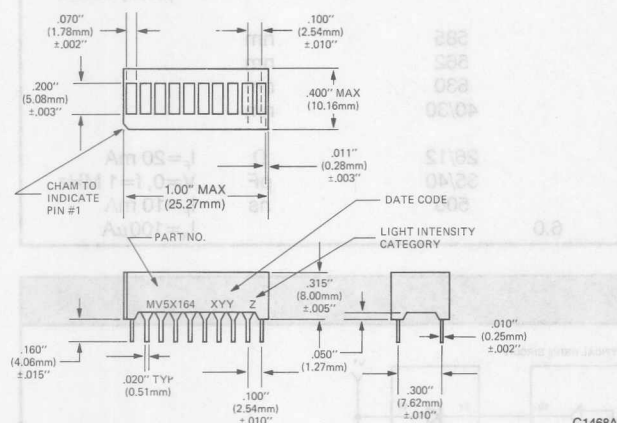


Fig. 6. Relative Efficiency vs. Duty Cycle

YELLOW MV53164
HIGH EFFICIENCY GREEN MV54164
HIGH EFFICIENCY RED MV57164

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED

DESCRIPTION

The MV5X164 series is a 10 segment bargraph display with separate anodes and cathodes for each light segment. The packages are end-stackable.

FEATURES

- Large segments, closely spaced
- End-stackable
- Fast switching—excellent for multiplexing
- Low power consumption
- Directly compatible with IC's
- Wide viewing angle
- Standard .3-inch DIP lead spacing
- Categorized for Luminous Intensity (See Note 1)

ABSOLUTE MAXIMUM RATINGS

	MV53164	MV54164	MV57164
Power dissipation at 25°C ambient	750 mW	750 mW	750 mW
Derate linearly from 50°C	-14.3 mW/°C	-14.3 mW/°C	-14.3 mW/°C
Storage and operating temperature	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Continuous forward current			
Total	200 mA	300 mA	300 mA
Per segment	25 mA	30 mA	30 mA
Reverse voltage			
Per segment	6.0 V	6.0 V	6.0 V
Soldering time at 260°C			
(See Notes 3 and 5)	5 sec.	5 sec.	5 sec.

TYPICAL THERMAL CHARACTERISTICS

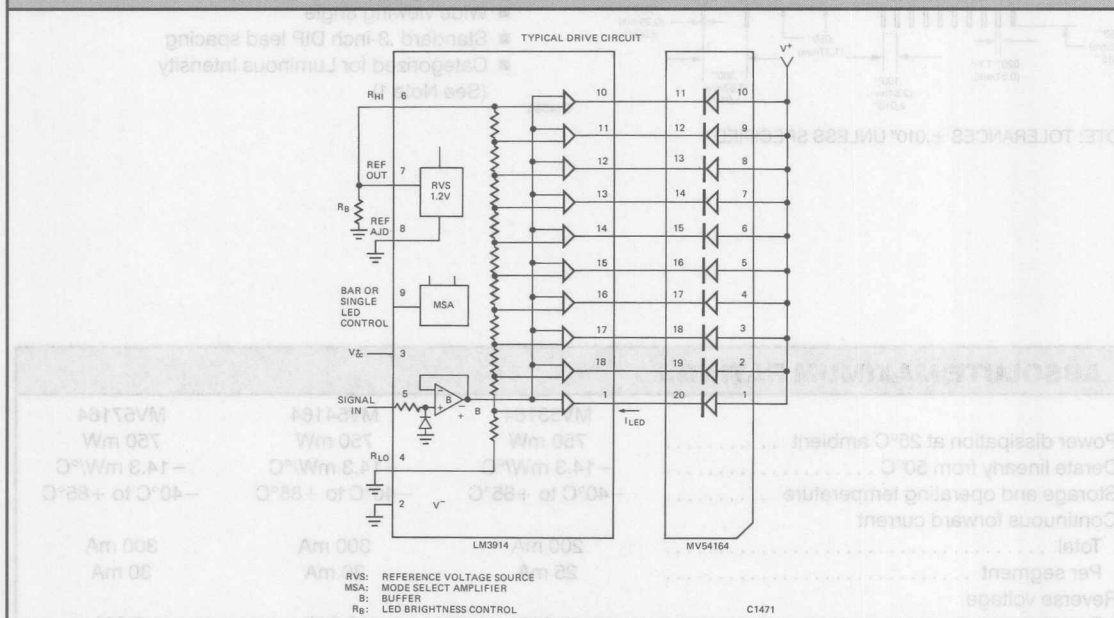
	MV53164	MV54164	MV57164
Thermal resistance junction to free air Φ_{JA}	160°C/W	160°C/W	160°C/W
Wavelength temperature coefficient (case temp.)	1.0 A/°C	1.0 A/°C	1.0 A/°C
Forward voltage temperature coefficient	-1.5 mV/°C	-1.4 mV/°C	-2.0 mV/°C

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage MV53164, MV57164/MV54164		2.0/2.2	2.5/3.0	V	$I_F = 10 \text{ mA}$
Luminous Intensity (unit average) (See Note 1)	510	1800		μcd	$I_F = 10 \text{ mA}$
Pulsed Luminous Intensity (MV54164)	710	2500		μcd	$I_F = 60 \text{ mA}$ peak; 1:6 DF
Peak emission wavelength				nm	
MV53164		585		nm	
MV54164		562		nm	
MV57164		630		nm	
Spectral line half width MV53164, MV57164/MV54164		40/30		nm	
Dynamic resistance				Ω	$I_F = 20 \text{ mA}$
Segment MV53164, MV57164/MV54164		26/12		Ω	$I_F = 20 \text{ mA}$
Capacitance MV53164, MV57164/MV54164		35/40		pF	$V = 0, f = 1 \text{ MHz}$
Switching time		500		ns	$I_F = 10 \text{ mA}$
Reverse voltage	6.0				$I_R = 100 \mu\text{A}$

TYPICAL DRIVE CIRCUIT



PIN CONNECTIONS

PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS	PIN NO.	ELECTRICAL CONNECTIONS
1	Bar 1 Anode	6	Bar 6 Anode	11	Bar 10 Cathode	16	Bar 5 Cathode
2	Bar 2 Anode	7	Bar 7 Anode	12	Bar 9 Cathode	17	Bar 4 Cathode
3	Bar 3 Anode	8	Bar 8 Anode	13	Bar 8 Cathode	18	Bar 3 Cathode
4	Bar 4 Anode	9	Bar 9 Anode	14	Bar 7 Cathode	19	Bar 2 Cathode
5	Bar 5 Anode	10	Bar 10 Anode	15	Bar 6 Cathode	20	Bar 1 Cathode

TYPICAL CURVES MV53164 MV54164 MV57164 (PER SEGMENT) (25°C Free Air Temperature)

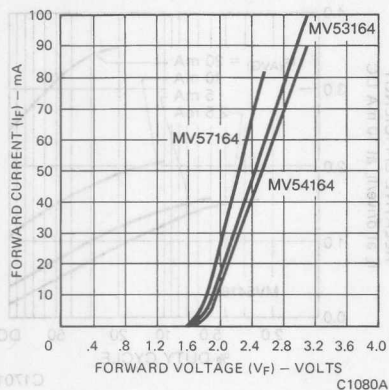


Fig. 1. Forward Current vs. Forward Voltage

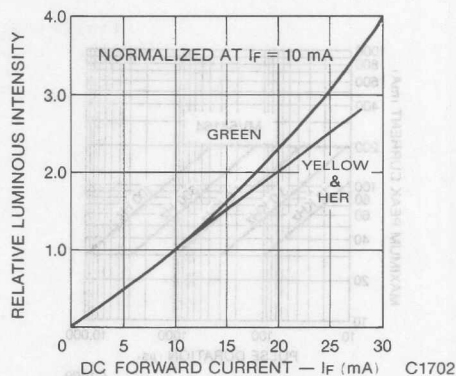


Fig. 2. Relative Luminous Intensity vs. DC Forward Current (Both LED Chips ON)

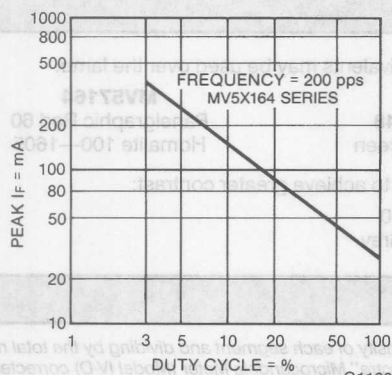


Fig. 3. Max Peak Current vs. Duty Cycle

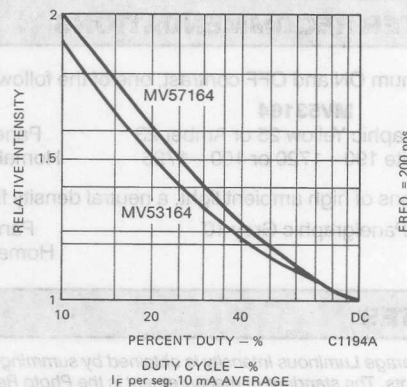


Fig. 4. Luminous Intensity vs. Duty Cycle

TYPICAL CURVES MV53164 MV54164 MV57164 (PER SEGMENT) (25°C Free Air Temperature) (Cont'd)

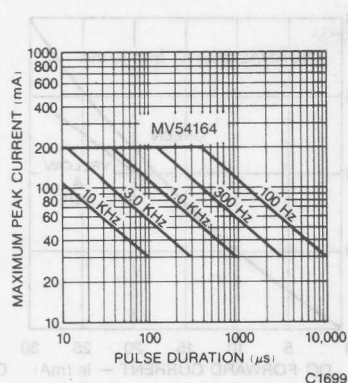


Fig. 5. Maximum Peak Current vs. Pulse Duration

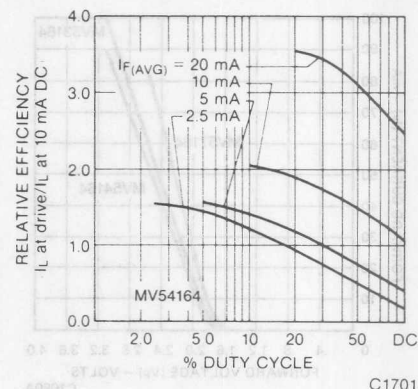


Fig. 6. Relative Efficiency vs. Duty Cycle

FILTER RECOMMENDATIONS

For optimum ON and OFF contrast, one of the following filters or equivalents may be used over the lamp:

MV53164

Panelgraphic Yellow 25 or Amber 23
Homalite 190—1720 or 100—1726

MV54164

Panelgraphic Green 48
Homalite 100—1440 Green

MV57164

Panelgraphic Red 60
Homalite 100—1605

In situations of high ambient light, a neutral density filter can be used to achieve greater contrast:

Panelgraphic Grey 10

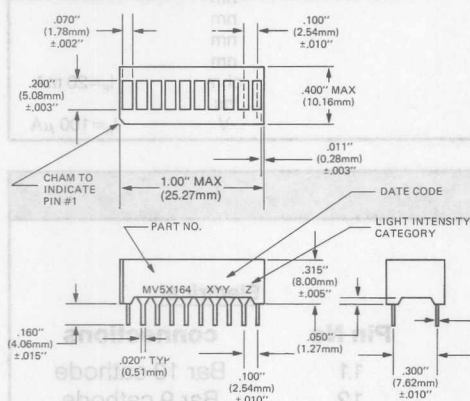
Panelgraphic Grey 10
Homalite 100—1266 Grey

NOTES

1. The average Luminous Intensity is obtained by summing the Luminous Intensity of each segment and dividing by the total number of segments. The standard of measurement is the Photo Research Corp. "Spectra" Microcandela Meter (Model IV-D) corrected for wavelength. Intensity will not vary more than $\pm 33.3\%$ between all segments within a unit.
2. Leads immersed to 1/16 inch (1.6 mm) from the body of the device. Maximum unit surface temperature is 140°C.
3. All units are categorized for Luminous Intensity. The Intensity category is marked on each part as a suffix letter to the part number.
4. For flux removal, Freon TF, Freon TE, Isopropanol or water may be used to their boiling points.

MV5A164 MV5D164
MV5B164 MV5E164
MV5C164

PACKAGE DIMENSIONS



NOTE: TOLERANCES ±.010" UNLESS SPECIFIED

DESCRIPTION

These are 10 segments multicolor bargraphs with separate anodes and cathode for each segment. The packages are stackable.

FEATURES

- Large segments, closely spaced
- End stackable
- Fast switching — excellent for multiplexing
- Low power consumption
- Directly compatible with ICs.
- Standard 0.3" DIP lead spacing

Custom multicolor bargraphs are available with minimum delivery requirements.

ABSOLUTE MAXIMUM RATING

Power dissipation at 25°C ambient	750 mW
Derate linearly from 50°C	-14.3 mW/°C
Storage and operating temperature	-40°C to 85°C
Continuous forward current	200 mA
Total	200 mA
Per segment	25 mA
Reverse voltage	6 V
Per segment	6 V
Soldering time at 260°C	5 Sec.

TYPICAL THERMAL CHARACTERISTICS

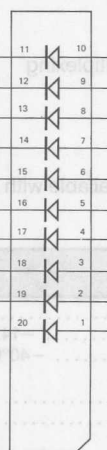
Thermal resistance Junction to free air θ_{JA}	160°C/W
Wavelength temperature coefficient (case temperature)	1.0 A/°C
Forward voltage temperature coefficient	
Yellow	-1.5 mV/°C,
Green	-1.4 mV/°C,
HER	-2.0 mV/°C

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

CONDITIONS	MIN	TYP	MAX	UNITS	TEST
Forward voltage (HER, Green, Yellow)		2.2	3.0	V	$I_F = 10 \text{ mA}$
Luminous intensity (average)	510	1800		μcd	$I_F = 10 \text{ mA}$
Peak emission wavelength					
High efficiency red (HER)		630		nm	
Green		562		nm	
Yellow		585		nm	
Spectral line half width		40		nm	
Dynamic resistance — segment		26		ohm	$I_F = 20 \text{ mA}$
Switching time		500		ns	
Reverse voltage		6.0		V	$I_R = 100 \mu\text{A}$

INTERNAL CIRCUIT DIAGRAMS



Pin connections

Electrical

Pin No	connections
1	Bar 1 anode
2	Bar 2 anode
3	Bar 3 anode
4	Bar 4 anode
5	Bar 5 anode
6	Bar 6 anode
7	Bar 7 anode
8	Bar 8 anode
9	Bar 9 anode
10	Bar 10 anode

Electrical

Pin No	connections
11	Bar 10 cathode
12	Bar 9 cathode
13	Bar 8 cathode
14	Bar 7 cathode
15	Bar 6 cathode
16	Bar 5 cathode
17	Bar 4 cathode
18	Bar 3 cathode
19	Bar 2 cathode
20	Bar 1 cathode

MULTICOLOR BARGRAPH SEGMENT COLOR

Segment	MV5A164	MV5B164	MV5C164	MV5D164	MV5E164
1	HER	HER	Green	Green	Green
2	HER	HER	Green	Green	Yellow
3	HER	Yellow	Green	Green	Yellow
4	Yellow	Yellow	Green	Green	Yellow
5	Yellow	Green	Green	Green	Yellow
6	Yellow	Green	Green	HER	Yellow
7	Yellow	Yellow	Yellow	HER	Yellow
8	Green	Yellow	Yellow	HER	HER
9	Green	HER	Yellow	HER	HER
10	Green	HER	HER	Yellow	HER

LAMPS

Alphanumeric Product Listing

Product	Page	Product	Page	Product	Page
FLV110	6-81	HLMP-6505	6-17	HLMP-M500	6-151
HLMP-0300	6-159	HLMP-6600	6-25	HLMP-M501	6-151
HLMP-0301	6-159	HLMP-6620	6-25	HLMP-M550	6-151
HLMP-0400	6-159	HLMP-6700	6-25	HLMP-M551	6-151
HLMP-0401	6-159	HLMP-6720	6-25	HLMP-Q105	6-17
HLMP-0503	6-159	HLMP-6800	6-25	HLMP-Q150	6-19
HLMP-0504	6-159	HLMP-6820	6-25	MP22	6-169
HLMP-1300	6-57	HLMP-7000	6-19	MP52	6-169
HLMP-1301	6-57	HLMP-7019	6-19	MP65	6-167
HLMP-1302	6-57	HLMP-7040	6-19	MR3050	6-135
HLMP-1320	6-43	HLMP-D101	6-63	MR3051	6-135
HLMP-1321	6-43	HLMP-D105	6-63	MR3350	6-135
HLMP-1340	6-43	HLMP-D150	6-51	MR3351	6-135
HLMP-1420	6-43	HLMP-D155	6-51	MR3450	6-135
HLMP-1440	6-43	HLMP-D400	6-131	MR3451	6-135
HLMP-1503	6-57	HLMP-D401	6-131	MR3750	6-135
HLMP-1520	6-43	HLMP-D600	6-131	MR3751	6-135
HLMP-1521	6-43	HLMP-D640	6-131	MR5000	6-21
HLMP-1523	6-57	HLMP-K101	6-63	MR5010	6-21
HLMP-1540	6-43	HLMP-K105	6-63	MR5020	6-21
HLMP-1700	6-61	HLMP-K150	6-51	MR5060	6-67
HLMP-1719	6-61	HLMP-K155	6-51	MR5310	6-21
HLMP-1790	6-61	HLMP-K400	6-47	MR5360	6-67
HLMP-3300	6-81	HLMP-K401	6-47	MR5361	6-67
HLMP-3301	6-81	HLMP-K402	6-47	MR5410	6-21
HLMP-3315	6-81	HLMP-K600	6-47	MR5460	6-67
HLMP-3316	6-81	HLMP-K640	6-47	MR5461	6-67
HLMP-3750	6-85	HLMP-M200	6-151	MR5660	6-67
HLMP-3850	6-85	HLMP-M201	6-151	MR5760	6-67
HLMP-3950	6-85	HLMP-M250	6-151	MR5761	6-67
HLMP-4700	6-61	HLMP-M251	6-151	MV2454	6-61
HLMP-4719	6-61	HLMP-M300	6-151	MV3350	6-85
HLMP-4740	6-61	HLMP-M301	6-151	MV3450	6-85
HLMP-6305	6-17	HLMP-M350	6-151	MV3750	6-85
HLMP-6405	6-17	HLMP-M351	6-151	MV49124A	6-163

LAMPS

Alphanumeric Product Listing

<u>Product</u>	<u>Page</u>	<u>Product</u>	<u>Page</u>	<u>Product</u>	<u>Page</u>
MV50152	6-77	MV53642	6-57	MV5774C	6-39
MV50154	6-77	MV5374C	6-39	MV5777C	6-35
MV5021A	6-73	MV5377C	6-35	MV57BL	6-9
MV5022A	6-73	MV53BL	6-9	MV5B54	6-55
MV5023A	6-73	MV54123	6-155	MV5B66	6-55
MV5024A	6-73	MV54124A	6-163	MV6000	6-13
MV5025A	6-73	MV54152	6-77	MV6053	6-89
MV5026A	6-73	MV54154	6-77	MV6151	6-139
MV5052	6-89	MV5437	6-145	MV6152	6-93
MV5053	6-89	MV5452	6-93	MV6153	6-127
MV5054A-1	6-89	MV5453	6-127	MV6154A	6-127
MV5054A-2	6-89	MV5454A	6-127	MV6300	6-13
MV5054A-3	6-89	MV5460	6-43	MV6351	6-139
MV5055	6-89	MV54624	6-43	MV6352	6-93
MV50640	6-57	MV54643	6-57	MV6353	6-127
MV5074C	6-39	MV54644	6-57	MV6354A	6-127
MV5075C	6-39	MV5474C	6-39	MV6400	6-13
MV5077C	6-35	MV5477C	6-35	MV6451	6-139
MV5094A	6-143	MV5491A	6-143	MV64520	6-93
MV50BL	6-9	MV54BL	6-9	MV64521	6-93
MV5152	6-93	MV55ABL	6-9	MV64530	6-127
MV5153	6-127	MV57123	6-155	MV64531	6-127
MV5154A	6-127	MV57124A	6-163	MV6454A	6-127
MV53123	6-155	MV57152	6-77	MV6461	6-71
MV53124A	6-163	MV57154	6-77	MV64BL	6-9
MV53152	6-77	MV5752	6-93	MV6661	6-71
MV53154	6-77	MV5753	6-127	MV6700	6-13
MV5352	6-93	MV5754A	6-127	MV6752	6-93
MV5353	6-127	MV5760	6-43	MV6753	6-127
MV5354A	6-127	MV57620	6-43	MV6754A	6-127
MV5360	6-43	MV57621	6-43	MV6951	6-139
MV53621	6-43	MV57622	6-43	MV8102	6-97
MV53622	6-43	MV57640	6-57	MV8103	6-97
MV53640	6-57	MV57641	6-57	MV8104	6-97
MV53641	6-57	MV57642	6-57	MV8111	6-101

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE 20 1/2 (DEGREES)	LUMINOUS INTENSITY (TYPE, mcd/ma)	PAGE
	MV50BL	Standard Red	Water Clear	80	3.0/20	6-9
	MV54BL	Standard Red	Red Light Diff.	80	3.5/20	6-9
	MV53BL	Yellow	Yellow Clear	80	6.0/20	6-9
	MV64BL	High Eff. Green	Green Clear	80	8.0/20	6-9
	MV55ABL	High Eff. Red	Red Diff.	40	3.0/5	6-9
	MV57BL	High Eff. Red	Red Clear	80	8.0/20	6-9
	MV6000	Red	Red Diffused	90	1.2/10	6-13
	MV6300	Yellow	Yellow Diffused	90	3.0/10	6-13
	HLMP-6405	Yellow	Yellow Clear	28	12/10	6-17
	HLMP-7019	Yellow	Yellow Diffused	90	0.6/2.0	6-19
	MV6400	Green	Green Diffused	90	3.0/10	6-13
	HLMP-6505	Green	Green Clear	28	12/10	6-17
	HLMP-7040	Green	Green Diffused	90	0.6/2.0	6-19
	HLMP-Q105	A1GaAs Red	Red Clear	28	35/20	6-17
	HLMP-Q150	A1GaAs Red	Red Diffused	90	1.8/1.0	6-19
	MV6700	Hi. Eff. Red	Red Diffused	90	3.0/10	6-13
	HLMP-6305	Hi. Eff. Red	Red Clear	28	12/10	6-17
	HLMP-7000	Hi. Eff. Red	Red Diffused	90	0.6/2.0	6-19
	MR5000	Red	Red Diffused	40	0.6/5V	6-21
	MR5010	Red	Red Diffused	40	1.2/5V	6-21
	MR5020	Red	Red Diffused	40	2.0/5V	6-21
	MR5310	Yellow	Yellow Diffused	40	1.5/5V	6-21
	MR5410	Green	Green Diffused	40	0.6/5V	6-21
	HLMP-6700	Yellow	Yellow Diffused	90	5/5V	6-25
	HLMP-6720	Yellow	Yellow Diffused	90	2/5V	6-25
	HLMP-6800	Green	Green Diffused	90	5/5V	6-25
	HLMP-6820	Green	Green Diffused	90	2/5V	6-25
	HLMP-6600	Hi. Eff. Red	Red Diffused	90	5/5V	6-25
	HLMP-6620	Hi. Eff. Red	Red Diffused	90	2/5V	6-25
	QTL P912-2	Red	Water Clear	25	80/20	6-27
	QTL P912-3	Yellow	Water Clear	25	30/20	6-27
	QTL P914-4	Green	Water Clear	25	50/20	6-27
	QTL P912-7	A1GaAs Red	Water Clear	25	170/20	6-27
	QTL P913-2	Red	Red Diffused	50	40/20	6-27
	QTL P913-3	Yellow	Yellow Diffused	50	15/20	6-27
	QTL P913-4	Green	Green Diffused	50	25/20	6-27
	QTL P913-7	A1GaAs Red	Red Diffused	50	108/20	6-27
	QTL P282-2	Red	Water Clear	150	5.6/20	6-31
	QTL P282-3	Yellow	Water Clear	150	6.0/20	6-31
	QTL P282-4	Green	Water Clear	150	5.6/20	6-31
	QTL P282-7	A1GaAs Red	Water Clear	150	17/20	6-31
	MV5077C	Standard Red	Red Diffused	180	1.8/20	6-35
	MV5377C	Yellow	Yellow Diffused	180	7.0/20	6-35
	MV5477C	Hi. Eff. Green	Green Diffused	180	7.0/20	6-35
	MV5777C	Hi. Eff. Red	Red Diffused	180	7.0/20	6-35

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE 2 θ 1/2 (DEGREES)	LUMINOUS INTENSITY (TYP. mcd/ma)	PAGE
 T-1	MV5074C	Standard Red	Red Clear	70	2.5/20	6-39
	MV5075C	Standard Red	Red Diffused	90	1.5/20	6-39
	MV5374C	Yellow	Yellow Diffused	90	9.5/20	6-39
	MV5474C	Hi. Eff. Green	Green Diffused	90	9.5/20	6-39
	MV5774C	Hi. Eff. Red	Red Diffused	90	9.5/20	6-39
 T-1 Clear Lens	HLMP-1440	Yellow	Pale Yellow Tint	45	6/20	6-43
	MV5360 (HLMP-1420)	Yellow	Pale Yellow Tint	45	12/10	6-43
	MV53621	Yellow	Yellow Clear	45	4/10	6-43
	MV53622	Yellow	Yellow Clear	45	5/10	6-43
	HLMP-1540	Hi. Eff. Green	Pale Green Tint	45	6/20	6-43
	MV5460 (HLMP-1520)	Hi. Eff. Green	Pale Green Tint	45	12/20	6-43
	MV54624 (HLMP-1521)	Hi. Eff. Green	Green Clear	45	12/20	6-43
	HLMP-K640	Pure Green	Water Clear	45	3/20	6-47
	HLMP-K155	AlGaAs Red	Clear	45	3/1.0	6-51
	HLMP-K105	AlGaAs Red	Clear	45	65/20	6-63
	HLMP-1340	Hi. Eff. Red	Pale Orange Tint	45	60/20	6-43
	MV5760 (HLMP-1320)	Hi. Eff. Red	Pale Orange Tint	45	12/10	6-43
	MV57620	Hi. Eff. Red	Red Clear	45	2/10	6-43
	MV57621	Hi. Eff. Red	Red Clear	45	4/10	6-43
	MV57622 (HLMP-1321)	Hi. Eff. Red	Red Clear	45	12/10	6-43
	MV5B66	Blue	Pale Blue Tint	14	3.0/20	6-55
 T-1 Diffused	MV50640	Standard Red	Red Diffused	90	1.5/20	6-57
	HLMP-1719	Yellow	Yellow Diffused	50	2.0/2	6-61
	MV53640	Yellow	Yellow Diffused	90	2.0/10	6-57
	MV53641	Yellow	Yellow Diffused	90	3.0/10	6-57
	MV53642	Yellow	Yellow Diffused	90	4.5/10	6-57
	HLMP-1790	Hi. Eff. Green	Green Diffused	50	2.0/2	6-61
	MV54643 (HLMP-1503)	Hi. Eff. Green	Green Diffused	90	5/20	6-57
	MV54644 (HLMP-1523)	Hi. Eff. Green	Green Diffused	90	10/20	6-57
	HLMP-K101	AlGaAs Red	Red Diffused	60	45/20	6-63
	HLMP-K150	AlGaAs Red	Red Diffused	60	2/1.0	6-51
	HLMP-1700	Hi. Eff. Red	Red Diffused	50	2.0/2	6-61
	MV57640 (HLMP-1300)	Hi. Eff. Red	Red Diffused	90	2.0/10	6-57
	MV57641 (HLMP-1301)	Hi. Eff. Red	Red Diffused	90	2.5/10	6-57
	MV57642 (HLMP-1302)	Hi. Eff. Red	Red Diffused	90	4.0/10	6-57
	HLMP-K400	Soft Orange	Orange Diffused	90	4.0/10	6-47
	HLMP-K401	Soft Orange	Orange Diffused	90	5.0/10	6-47
	HLMP-K402	Soft Orange	Orange Diffused	90	6.5/10	6-47
	HLMP-K600	Pure Green	Green Diffused	90	4.5/10	6-47
 T-1 Resistor	MR5060	Red	Red Diffused	60	1.5/5V	6-67
	MR5660	Red	Non Tinted Diffused	60	1.5/5F	6-67
	MR5360	Yellow	Yellow Diffused	60	4.0/5F	6-67
	MR5361	Yellow	Yellow Diffused	60	4.0/12V	6-67
	MR5460	Hi. Eff. Green	Green Diffused	60	4.0/5V	6-67
	MR5461	Hi. Eff. Green	Green Diffused	60	4.0/12V	6-67
	MR5760	Hi. Eff. Red	Red Diffused	60	4.0/5V	6-67
	MR5761	Hi. Eff. Red	Red Diffused	60	4.0/12V	6-67
 T-1 White Contrast White Diffused	MV6461	H.E.G./AlGaAs	White Diffused	100	10/20	6-71
	MV6661	H.E.R./AlGaAs	White Diffused	100	10/20	6-71
 T-1 1/4 Taper	MV5021A	Standard Red	White Diffused	90	1.6/20	6-73
	MV5022A	Standard Red	Red Clear	90	1.6/20	6-73
	MV5023A	Standard Red	Red Diffused	90	1.6/20	6-73
	MV5024A	Standard Red	Red Diffused	60	3.0/20	6-73
	MV5025A	Standard Red	Red Diffused	180	0.4/20	6-73
	MV5026A	Standard Red	Deep Red Diffused	90	0.6/20	6-73

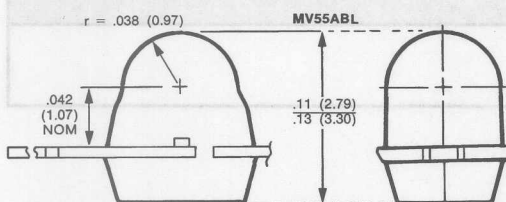
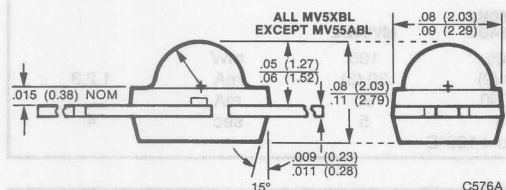
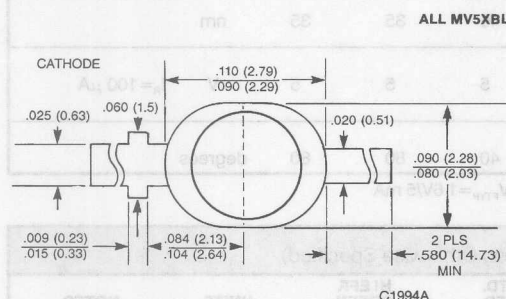
PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE 2 θ 1/2 (DEGREES)	LUMINOUS INTENSITY (TYP. mcd/ma)	PAGE
 T-1 1/4 Bullet	MV50152	Standard Red	Red Clear	45	2.0/10	6-77
	MV53152	Yellow	Amber Clear	45	10/10	6-77
	MV54152	Hi. Eff. Green	Green Clear	45	15/10	6-77
	MV57152	Hi. Eff. Red	Orange Clear	45	10/10	6-77
	MV50154	Standard Red	Red. Lightly Diff.	50	1.5/10	6-77
	MV53154	Yellow	Amber Lightly Diff.	50	8/10	6-77
	MV54154	Hi. Eff. Green	Green Lightly Diff.	50	12/10	6-77
	MV57154	Hi. Eff. Red	Orange Lightly Diff.	50	8/10	6-77
 T-1 Low Profile	FLV110	Standard Red	Red. Diffused	70	3.0/20	6-81
 T-1 Clear Stand-off	HLMP-3850 (Ultrabright)	Yellow	Pale Yellow Tint	24	150/20	6-85
	HLMP-3950 (Ultrabright)	Hi. Eff. Green	Pale Green Tint	24	150/20	6-85
	HLMP-3750 (Ultrabright)	Hi. Eff. Red	Pale Orange Tint	24	150/20	6-85
	HLMP-D105	AlGaAs Red	Clear	24	240/20	6-63
	HLMP-D155	AlGaAs Red	Clear	24	10/1.0	6-51
 T-1 Clear	MV5052	Standard Red	Red Clear	72	2.0/20	6-89
	MV3350	Yellow	Pale Yellow Tint	24	150/20	6-85
	MV5352/MV6352	Yellow	Yellow Clear	28	90/20	6-93
	MV3450	Hi. Eff. Green	Pale Green Tint	24	150/20	6-85
	MV5452/MV64520	Hi. Eff. Green	Green Clear	35	25/20	6-93
	MV64521	Hi. Eff. Green	Green Clear	35	100/20	6-93
	MV5152/MV6152	Hi. Eff. Red	Amber Clear	28	100/20	6-93
	MV3750	Hi. Eff. Red	Pale Orange Tint	24	150/20	6-85
	MV5752/MV6752	Hi. Eff. Red	Red Clear	28	100/20	6-93
	HLMP-3315	Hi. Eff. Red	Red Clear	35	18/10	6-81
	HLMP-3316	Hi. Eff. Red	Red Clear	35	35/10	6-81
	MV5B54	Blue	Pale Blue Tint	24	2.0/20	6-55
	HLMP-D640	Pure Green	Water Clear	24	60/20	6-131
 T-1 Diffused Narrow Angle	MV5054A-1	Standard Red	Red Diffused	24	2.0/10	6-89
	MV5054A-2	Standard Red	Red Diffused	24	3.0/10	6-89
	MV5054A-3	Standard Red	Red Diffused	24	4.0/10	6-89
	HLMP-4719	Yellow	Yellow Diffused	35	2.0/2	6-61
	MV5354A/MV6354A	Yellow	Yellow Diffused	24	25/20	6-127
	HLMP-4740 (MV2454)	Hi. Eff. Green	Green Diffused	35	3.0/2	6-61
	MV5454A/MV6454A	Hi. Eff. Green	Green Diffused	24	30/20	6-127
	MV5154A/MV6154A	Hi. Eff. Red	Amber Diffused	24	25/20	6-127
	HLMP-4700	Hi. Eff. Red	Red Diffused	35	2.0/2	6-61
	MV5754A/MV6754A	Hi. Eff. Red	Red Diffused	24	25/20	6-127
	MV8190	AlGaAs Red	Red Diffused	45	100/20	6-109
	MV8191	AlGaAs Red	Red Diffused	45	200/20	6-109

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE $\theta_{1/2}$ (DEGREES)	LUMINOUS INTENSITY (TYP. mcd/mA)	PAGE
T-1$\frac{1}{2}$ Super Bright Clear lens 	MV8102	AlGaAs Red	Water Clear	20	370/20	6-97
	MV8103	AlGaAs Red	Water Clear	20	940/20	6-97
	MV8104	AlGaAs Red	Water Clear	20	1500/20	6-97
	MV8111	AlGaAs Red	Water Clear	12	370/20	6-101
	MV8112	AlGaAs Red	Water Clear	12	940/20	6-101
	MV8113	AlGaAs Red	Water Clear	12	1500/20	6-101
	MV8114	AlGaAs Red	Water Clear	12	2400/20	6-101
	MV8132	AlGaAs Red	Water Clear	30	940/20	6-105
	MV8133	AlGaAs Red	Water Clear	30	1500/20	6-105
	MV8140	AlGaAs Red	Water Clear	45	220/20	6-109
	MV8141	AlGaAs Red	Water Clear	45	370/20	6-109
	MV8313	Yellow	Water Clear	12	940/20	6-113
	MV8314	Yellow	Water Clear	12	1500/20	6-113
	MV8332	Yellow	Water Clear	30	940/20	6-105
	MV8333	Yellow	Water Clear	30	1500/20	6-105
	MV8341	Yellow	Water Clear	45	220/20	6-117
	MV8342	Yellow	Water Clear	45	370/20	6-117
	MV8410	Green	Water Clear	12	240/20	6-121
	MV8411	Green	Water Clear	12	370/20	6-121
	MV8703	Orange	Water Clear	20	940/20	6-123
T-1$\frac{1}{2}$ Diffused Wide Angle 	MV5053/MV6053	Standard Red	Red Diffused	80	1.6/20	6-89
	MV5055	Standard Red	Red Diffused	150	0.1/20	6-89
	MV5353/MV6353	Yellow	Yellow Diffused	65	15/20	6-127
	MV5453/MV64530	Hi. Eff. Green	Green Diffused	75	20/20	6-127
	MV64531	Hi. Eff. Green	Green Diffused	75	25/20	6-127
	MV5153/MV6153	Hi. Eff. Red	Amber Diffused	65	15/20	6-127
	MV5753/MV6753	Hi. Eff. Red	Red Diffused	65	15/20	6-127
	HLMP-3300	Hi. Eff. Red	Red Diffused	65	3.5/10	6-81
	HLMP-3301	Hi. Eff. Red	Red Diffused	65	7.0/10	6-81
	HLMP-D101	AlGaAs Red	Red Diffused	65	70/20	6-63
	HLMP-D150	AlGaAs Red	Red Diffused	65	3/1.0	6-51
	HLMP-D400	Soft Orange	Orange Diffused	60	3.5/10	6-131
T-1$\frac{1}{2}$ Resistor 	MR3050	Red	Red Diffused	60	2.0/5V	6-135
	MR3051	Red	Red Diffused	60	2.0/12V	6-135
	MR3350	Yellow	Yellow Diffused	60	4.0/5V	6-135
	MR3351	Yellow	Yellow Diffused	60	4.0/12V	6-135
	MR3450	Hi. Eff. Green	Green Diffused	60	4.0/5V	6-135
	MR3451	Hi. Eff. Green	Green Diffused	60	4.0/12V	6-135
	MR3750	Hi. Eff. Red	Red Diffused	60	4.0/5V	6-135
	MR3751	Hi. Eff. Red	Red Diffused	60	4.0/12V	6-135

PACKAGE	PART NUMBER	SOURCE COLOR	LENS TYPE	VIEWING ANGLE 2 θ 1/2 (DEGREES)	LUMINOUS INTENSITY (TYP. mcd/ma)	PAGE
T-1 1/4 Max. Contrast White Diffused 	MV6351	Yellow	Pale Yellow Diffused	70	12.0/20	6-139
	MV6451	Hi. Eff. Green	Pale Green Diffused	70	12.0/20	6-139
	MV6151	Hi. Eff. Red	Pale Orange Diffused	70	12.0/20	6-139
	MV6951	Deep Red	Pale Pink Diffused	70	12.0/20	6-139
T-1 1/4 Bicolor White Diffused Stand Off 	MV5094A (Bipolar)	Red/Red	White Diffused	75	6.0/20	6-143
	MV5491A (Bicolor)	Red/Green	White Diffused	100	6.0/20	6-143
T-1 1/4 Max. Contrast White 	MV5437	H.E.G./H.E.R.	White Diffused	100	6/20	6-145
10 mm Clear Lens 	MV9100	AlGaAs Red	Water Clear	45	940/20	6-147
	MV9101	AlGaAs Red	Water Clear	45	1500/20	6-147
	MV9102	AlGaAs Red	Water Clear	45	2400/20	6-147
4mm Flat Top 	HLMP-M200/201	Hi. Eff. Red	Tint/Diffused	135	5/20	6-151
	HLMP-M250/251	Hi. Eff. Red	Tint/Clear	80	5/10	6-151
	HLMP-M300/301	Yellow	Tint/Diffused	135	5/20	6-151
	HLMP-M350/351	Yellow	Tint/Clear	80	5/10	6-151
	HLMP-M500/501	Hi. Eff. Green	Tint/Diffused	135	7/20	6-151
	HLMP-M550/551	Hi. Eff. Green	Tint/Clear	80	10/10	6-151
Rectangular 	MV53123	Yellow	Yellow Diffused	100	4.0/20	6-155
	MV54123	Hi. Eff. Green	Green Diffused	100	4.0/20	6-155
	MV57123	Hi. Eff. Red	Red Diffused	100	4.0/20	6-155
	HLMP-0400	Yellow	Yellow Diffused	100	2.5/20	6-159
	HLMP-0401	Yellow	Yellow Diffused	100	5.0/20	6-159
	HLMP-0503	Hi. Eff. Green	Green Diffused	100	3.0/20	6-159
	HLMP-0504	Hi. Eff. Green	Green Diffused	100	5.0/20	6-159
	HLMP-0300	Hi. Eff. Red	Red Diffused	100	2.5/20	6-159
	HLMP-0301	Hi. Eff. Red	Red Diffused	100	5.0/20	6-159
	MV53124A	Yellow	Yellow Diffused	100	6.0/20	6-163
	MV54124A	Hi. Eff. Green	Green Diffused	100	6.0/20	6-163
	MV57124A	Hi. Eff. Red	Red Diffused	100	6.0/20	6-163
	MV49124A (Bicolor)	Red/Green	White Diffused	100	6.0/20	6-163

			YELLOW	MV53BL
		HIGH EFFICIENCY GREEN		MV64BL
STANDARD RED	MV50BL	HIGH EFFICIENCY RED		MV55ABL
STANDARD RED	MV54BL	HIGH EFFICIENCY RED		MV57BL

PACKAGE DIMENSIONS



DESCRIPTION

The family of MV53BL, MV54BL, MV57BL, and MV64BL are non-diffused, tinted subminiature T- $\frac{3}{4}$ radial lamps with wide viewing angle.

The MV50BL is Water Clear with wide viewing angle while MV55ABL is tinted, non-diffused narrow viewing angle specified at 5 mA.

FEATURES

The subminiature LED lamps are intended for high volume, low-cost status indication on PC boards and for backlighting switches and keyboard keys. The lamps are compatible with vapor phase reflow surface mount and conventional soldering switches.

- Subminiature package
- All colors
- Solid state reliability
- Choice of viewing angle

NOTES:

- NOTES:
1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCES ARE $\pm .010$ INCH UNLESS SPECIFIED

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT
MV50BL	Standard Red	Water Clear
MV54BL	Standard Red	Red
MV53BL	Yellow	Yellow
MV64BL	High Efficiency Green	Green
MV55ABL	High Efficiency Red	Red/Narrow
MV57BL	High Efficiency Red	Red

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MV50BL	MV53BL	MV54BL	MV55ABL	MV57BL	MV64BL	UNITS	CONDITIONS
Luminous Intensity	min. typ. I_v	0.5 3.0	1.0 6.0	0.4 3.5	* *	1.0 8.0	1.0 8.0	mcd mcd	$I_F = 20\text{ mA}$ $I_F = 20\text{ mA}$
Forward voltage	max. typ. V_F	2.0 1.65	3.0 2.1	2.0 1.65	* 2.2	3.0 2.1	3.0 2.2	V V	$I_F = 20\text{ mA}$ $I_F = 20\text{ mA}$
Peak wavelength	λ_p	660	585	660	635	635	565	nm	
Spectral line halfwidth	typ.	20	35	20	45	35	35	nm	
Reverse breakdown voltage	min. V_{BR}	5	5	5	5	5	5	V	$I_R = 100\text{ }\mu\text{A}$
Total viewing angle (5)	typ. $2\theta_{1/2}$	80	80	80	40	80	80	degrees	

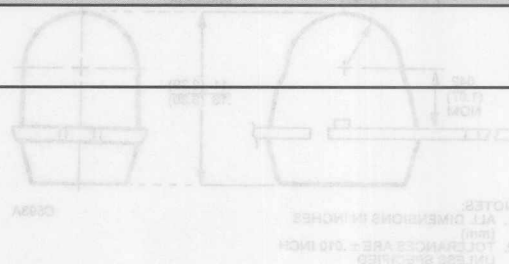
*MV55AB I_v min=0.2 mcd/5 mA, $I_{VTP}=3.0$ mcd/5 mA, V_F max=2.0 V/5 mA, $V_{FTYP}=1.6$ V/5 mA

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	YELLOW/ HI EFF. RED	STD. RED	HI EFF. GREEN	UNITS	NOTES
	MV53BL MV55ABL MV57BL	MV50BL MV54BL	MV64BL		
Power dissipation	85/105	105	105	mW	
Average forward current	20(3)/35 (1)	50 (2)	30 (3)	mA	1,2,3
Peak forward current (1 μs , PW 0.1% DF)	60/90	1000	90	mA	
Lead soldering time at 230°C	5	5	5	sec	4
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$				

NOTES

1. Derate linearly from 50°C at $0.7\text{ mA}/^\circ\text{C}$
2. Derate linearly from 50°C at $1.0\text{ mA}/^\circ\text{C}$
3. Derate linearly from 50°C at $0.6\text{ mA}/^\circ\text{C}$



TYPE	WAVELENGTH	EFFICIENCY
MV50BL	Standard Red	High Efficiency Red
MV53BL	Standard Red	High Efficiency Red
MV54BL	Standard Red	High Efficiency Red
MV55ABL	Standard Red	High Efficiency Red
MV57BL	Standard Red	High Efficiency Red
MV64BL	Standard Red	High Efficiency Red

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

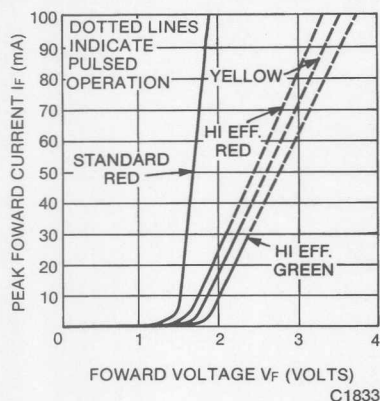


Fig. 1. Forward Current vs. Forward Voltage

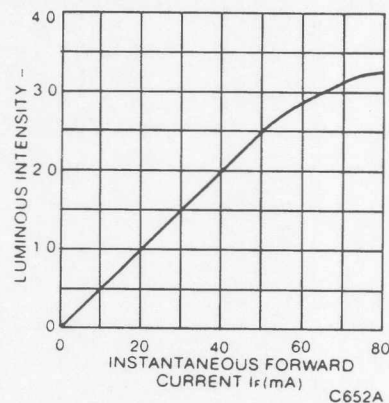


Fig. 2. Luminous Intensity vs. Forward Current

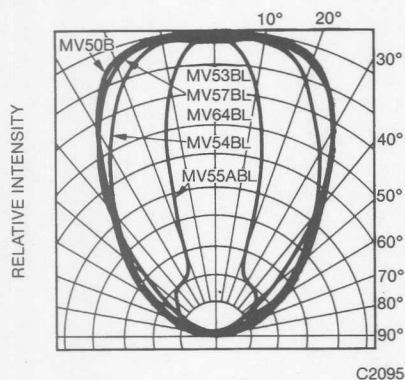


Fig. 3. Spatial Distribution

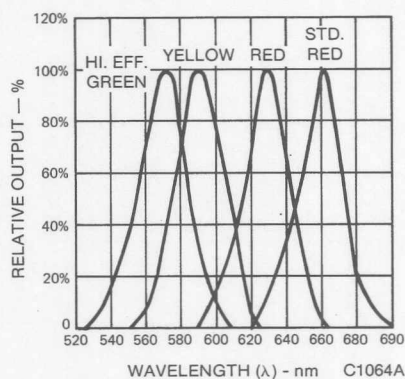


Fig. 4. Spectral Distribution

NOTES

- The leads of the device were immersed in molten solder, heated to a temperature of 230°C , to a point $1/16$ inch (1.6mm) from the body of the device per MIL-S-750, with dwell time of 5 sec.
- The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.

TYPICAL ELECTRICAL AND OPTICAL CHARACTERISTICS

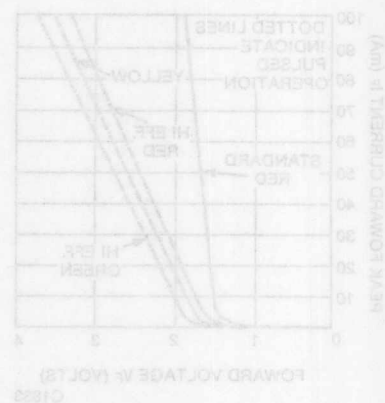


Fig. 1. Forward Current vs. Forward Voltage

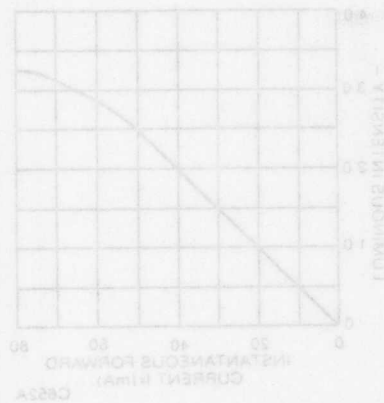


Fig. 2. Luminous Intensity vs. Forward Current

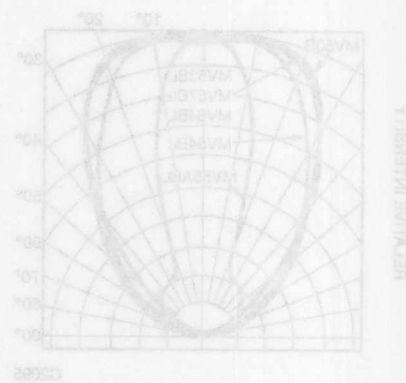


Fig. 3. Spatial Distribution

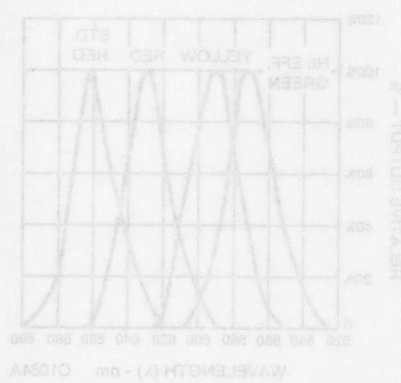


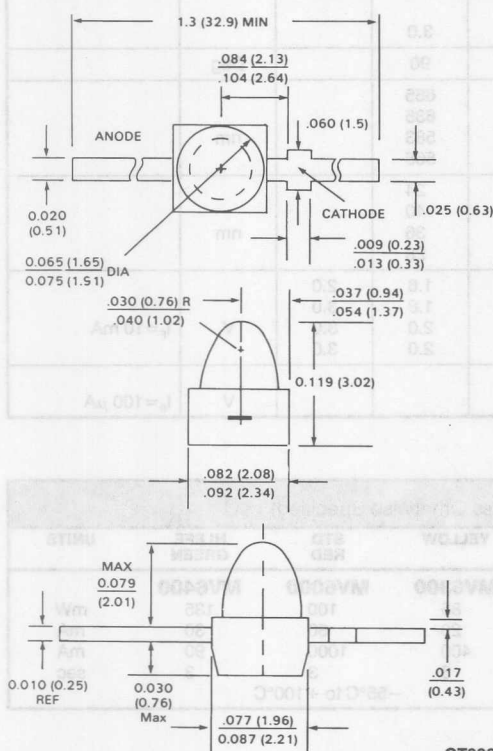
Fig. 4. Spectral Distribution

1. The leads of the device were immersed in molten solder heated to a temperature of 230°C. to a point 1/16 inch (1.6mm) from the body of the device per MIL-S-1950, with dwell time of 3 sec.

2. The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.

**RED MV6000
HIGH EFFICIENCY RED MV6700
YELLOW MV6300
HIGH EFFICIENCY GREEN MV6400**

PACKAGE DIMENSIONS



DESCRIPTION

These subminiature lamps are constructed as axial leaded devices. They complement the MV5XBL series. The plastic lamp packages in this series have a "square-base" design; versus a "round" base for the MV5XBL series. The optics of wide-angle beam emission and sharp ON/OFF contrast are derived from the tinted, diffused epoxy lens package.

"YOKE" and "GULL-WING" lead bends and SMT tape & reel versions are available (see separate data sheet).

FEATURES

- Subminiature T-3/4 package
- Low package profile
- Axial leads
- Wide viewing angle
- SMT versions

NOTES:

1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCES ARE $\pm .010$ INCH UNLESS OTHERWISE SPECIFIED

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR
MV6000	Red	Red Diffused
MV6700	High Efficiency Red	Red Diffused
MV6300	Yellow	Yellow Diffused
MV6400	High Efficiency Green	Green Diffused

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	DEVICE MV	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity	I_v	Standard Red 6000	0.5	1.2		mcd	$I_F = 10\text{ mA}$
		High Efficiency Red 6700	1.0	3.0			
		Yellow 6300	1.0	3.0			
		High Efficiency Green 6400	1.0	3.0			
Total viewing angle	$2\theta_{1/2}$	All		90		Deg	
Peak wavelength	λ_p	Standard Red		655		nm	
		High Efficiency Red		635			
		Yellow		583			
		High Efficiency Green		565			
Spectral line halfwidth	$\Delta\lambda_{1/2}$	Standard Red		24		nm	
		High Efficiency Red		40			
		Yellow		36			
		High Efficiency Green		28			
Forward voltage	V_F	Standard Red	1.4	1.6	2.0	V	$I_F = 10\text{ mA}$
		High Efficiency Red	1.5	1.8	3.0		
		Yellow	1.5	2.0	3.0		
		High Efficiency Green	1.5	2.0	3.0		
Reverse breakdown voltage	V_R	All	5.0			V	$I_R = 100\text{ }\mu\text{A}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	HI EFF. RED	YELLOW	STD RED	HI EFF. GREEN	UNITS
	MV6700	MV6300	MV6000	MV6400	
Power dissipation	135	85	100	135	mW
Average forward current	30	20	50	30	mA
Peak forward current (see Note 1)	400	400	1000	90	mA
Lead soldering time at 260°C	3	3	3	3	sec
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$				

NOTE

1. $1\mu\text{s}$, PW 0.1% DF

TYPE	COLOR	LENS
MV6000	Red	Red Diffused
MV6700	High Efficiency Red	Red Diffused
MV6300	Yellow	Yellow Diffused
MV6400	High Efficiency Green	Green Diffused

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

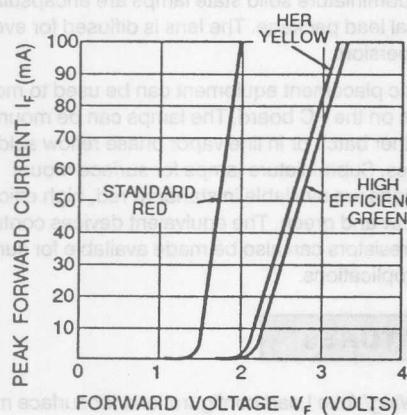


Fig. 1. Forward Current vs. Forward Voltage

QT906A-02

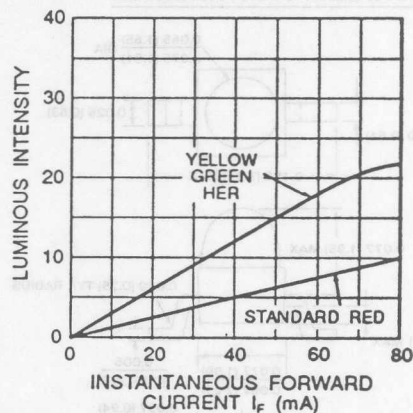


Fig. 2. Luminous Intensity vs. Forward Current

QT906A-03

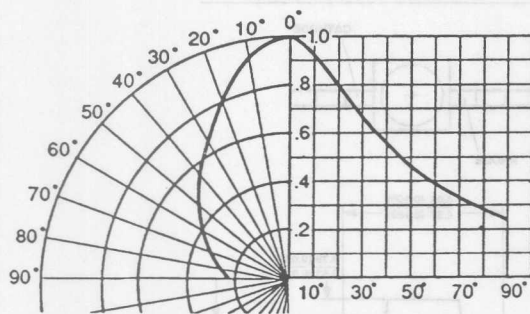


Fig. 3. Relative Luminous Intensity vs. Angular Displacement

QT906A-04

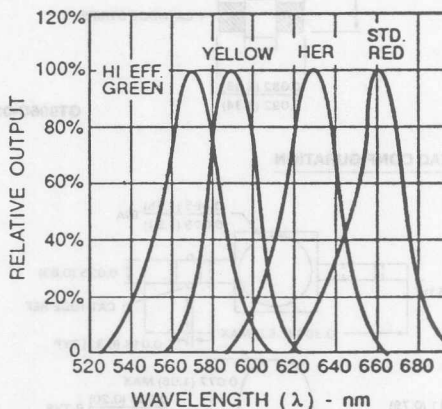


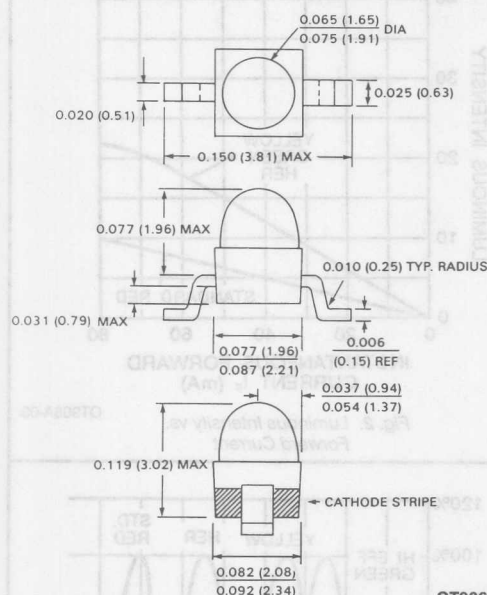
Fig. 4. Spectral Distribution

QT906A-05

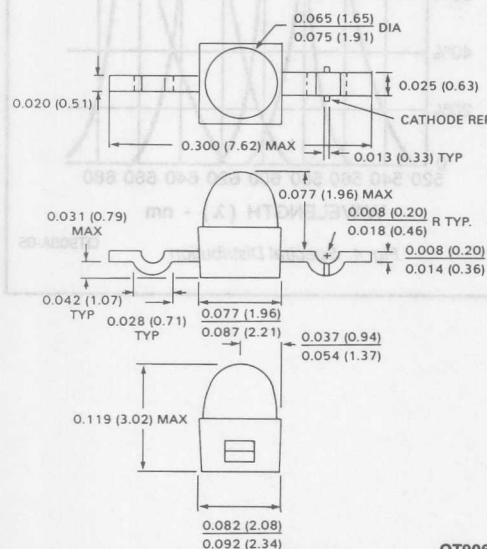
SURFACE MOUNT OPTIONS FOR MV6X00 SUBMINIATURE LAMPS (T-3/4) GULL WING/YOKE LEAD/Z-BEND CONFIGURATION

LEAD BEND OPTIONS

GULL WING LEAD CONFIGURATION



YOKE LEAD CONFIGURATION



DESCRIPTION

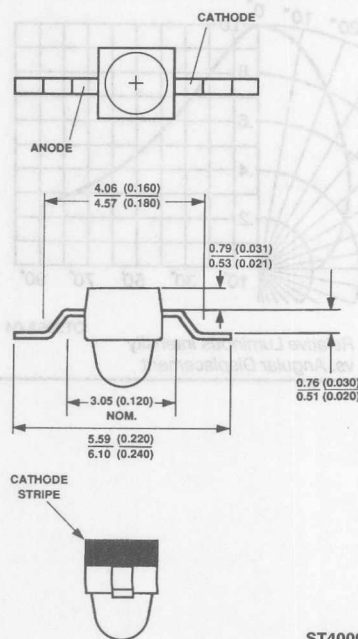
These subminiature solid state lamps are encapsulated in an axial lead package. The lens is diffused for even light dispersion.

Automatic placement equipment can be used to mount the LEDs on the PC board. The lamps can be mounted using either batch or in line vapor phase reflow solder processes. Subminiature lamps for surface mount applications are available in standard red, high efficiency red, yellow and green. The equivalent devices containing integral resistors can also be made available for surface mount applications.

FEATURES

- Gull Wing/Yoke Lead configurations for surface mount applications
- Compatible with automatic placement equipment
- Compatible with vapor phase reflow solder processes
- Long life—solid state reliability
- Supplied on tape and reel or in bulk packaging

Z-BEND LEAD CONFIGURATION



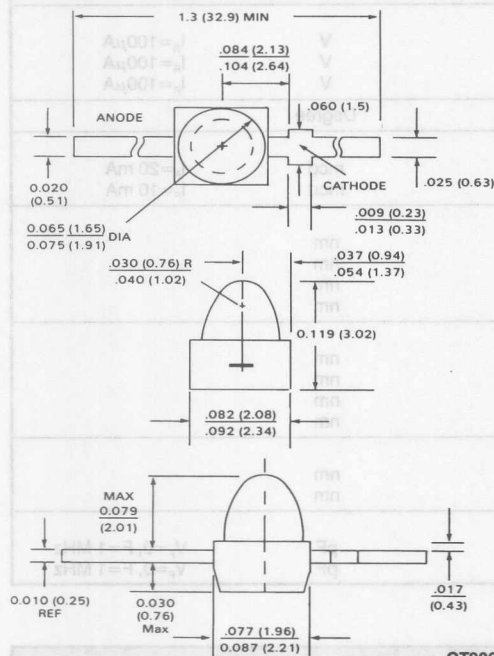
NOTES:

1. ALL DIMENSIONS ARE IN INCHES (mm)
2. ALL TOLERANCES ARE $\pm .010"$ (.254 mm) UNLESS OTHERWISE SPECIFIED.

**AlGaAs HLMP-Q105
YELLOW HLMP-6405**

**HIGH EFF. RED HLMP-6305
HIGH EFF. GREEN HLMP-6505**

PACKAGE DIMENSIONS



DESCRIPTION

These subminiature are constructed as axial leaded devices. Non-diffused packages are used to provide high brightness.

FEATURES

- Subminiature T 3/4 package
- Low package profile
- Excellence for back lighting and space limited applications
- "Gull Wing", "Yoke" and "Z" lead bents are available
- Axial and SMT version tape and reel are available

NOTES:

1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCES ARE $\pm .010$ INCH UNLESS OTHERWISE SPECIFIED

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	A.RED	HER	YELLOW	GREEN	UNITS
Power dissipation	85	135	85	135	mW
DC forward current	30	30	20	30	mA
Peak forward current	300	90	60	90	mA
Reverse voltage at $I_R = 100 \mu\text{A}$	5	5	5	5	V
Operating temperature range	-20 to 100	-55 to 100	-55 to 100	-55 to 100	$^\circ\text{C}$

Storage temperature range	-55 $^\circ\text{C}$ to 100 $^\circ\text{C}$
Lead soldering time at 260 $^\circ\text{C}$	3 Sec.
Surface mount reflow soldering	
Convective IR at 235 $^\circ\text{C}$	90 Sec
Vapour phase at 213 $^\circ\text{C}$	3 min

NOTE 1 - 1 μs PW & 0.1% DF

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance $\theta_{\text{Junc to pin}}$ HLMP-Q105

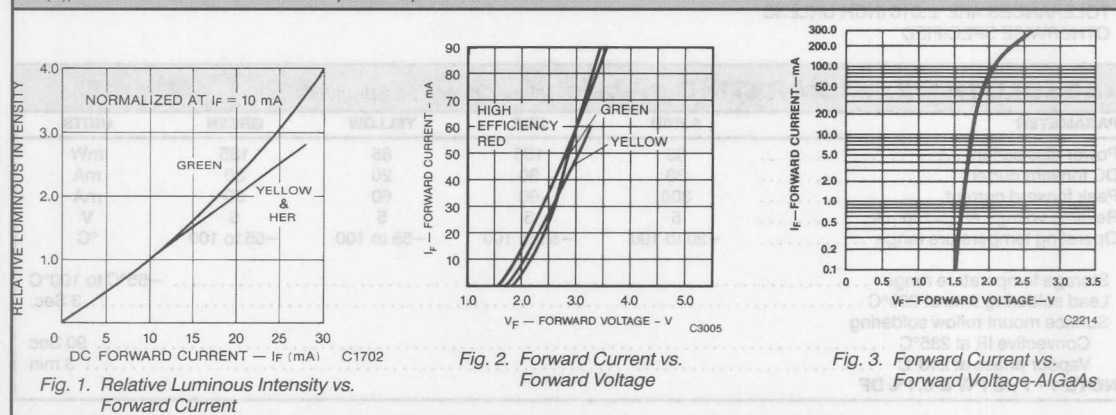
220 $^\circ\text{C}/\text{W}$

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage - V_F					
HLMP-Q105		1.8	2.2	V	$I_F = 20\text{ mA}$
HLMP-6305/6405/6505	1.5	1.8	3.0	V	$I_F = 10\text{ mA}$
Reverse voltage - V_R					
HLMP-Q105	5	15		V	$I_R = 100\mu\text{A}$
HLMP-6305	5	30		V	$I_R = 100\mu\text{A}$
HLMP-6405/6505	5	50		V	$I_R = 100\mu\text{A}$
Viewing angle - $2\theta_{1/2}$		28		Degree	
Luminous intensity - I_L					
HLMP-Q105	15	35		mcd	$I_F = 20\text{ mA}$
HLMP-6305/6405/6505	3	12		mcd	$I_F = 10\text{ mA}$
Peak wavelength					
HLMP-Q105		645		nm	
HLMP-6305		635		nm	
HLMP-6405		583		nm	
HLMP-6505		565		nm	
Dominant wavelength					
HLMP-Q105		637		nm	
HLMP-6305		626		nm	
HLMP-6405		585		nm	
HLMP-6505		569		nm	
Spectral line half width					
HLMP-Q105		20		nm	
HLMP-6305/6405/6505		35		nm	
Capacitance - C					
HLMP-Q105		30		pF	$V_F = 0, F = 1\text{ MHz}$
HLMP-6305/6405/6505		15		pF	$V_F = 0, F = 1\text{ MHz}$

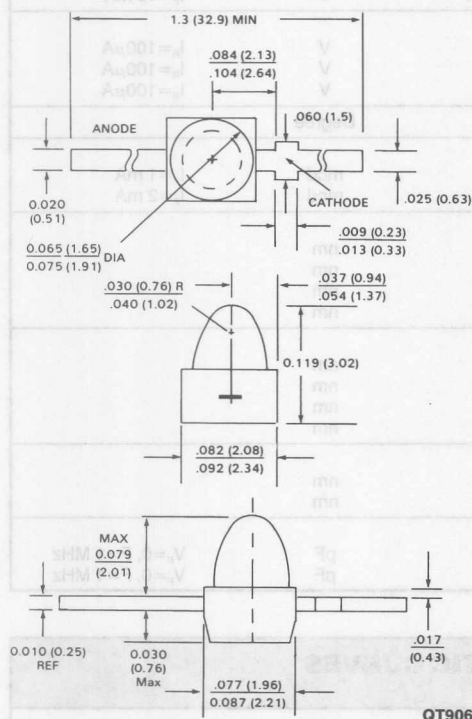
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)



**AlGaAs RED HLMP-Q150 HIGH EFF. RED HLMP-7000
YELLOW HLMP-7019 HIGH EFF. GREEN HLMP-7040**

PACKAGE DIMENSIONS



DESCRIPTION

These subminiature lamps are constructed as axial leaded devices. High brightness chips; such as AlGaAs red and HER chips are used to achieve the low current and high brightness requirement. Color tinted, diffused epoxy packages are used for these packages.

FEATURES

- Subminiature T 3/4 packages
- Low package profile
- Wide viewing angle
- Low current, high brightness
- Ideal for back lighting and space limited applications
- "Gull Wing", "Yoke" and "Z" lead bents are available
- Axial and SMT version tape and reel are available.

NOTES:
1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCES ARE $\pm .010$ INCH UNLESS OTHERWISE SPECIFIED

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	A. Red	HER	YELLOW	GREEN	UNITS
Power dissipation	85	135	85	135	mW
DC forward current	30	30	20	30	mA
Peak forward current note1	300	90	60	90	mA
Reverse voltage at $I_R = 100\mu\text{A}$	5	5	5	5	V
Operating temperature range	-20 to 100	-55 to 100	-55 to 100	-55 to 100	$^\circ\text{C}$
Storage temperature range	-55 $^\circ\text{C}$ to 100 $^\circ\text{C}$				
Lead soldering time at 260 $^\circ\text{C}$	3 Sec				
Surface mount reflow soldering					
Convective IR at 235 $^\circ\text{C}$	90 Seconds				
Vapour phase at 213 $^\circ\text{C}$	3 Minutes				

NOTE 1-1 μs PW & 0.1% DF

TYPICAL THERMAL CHARACTERISTICS

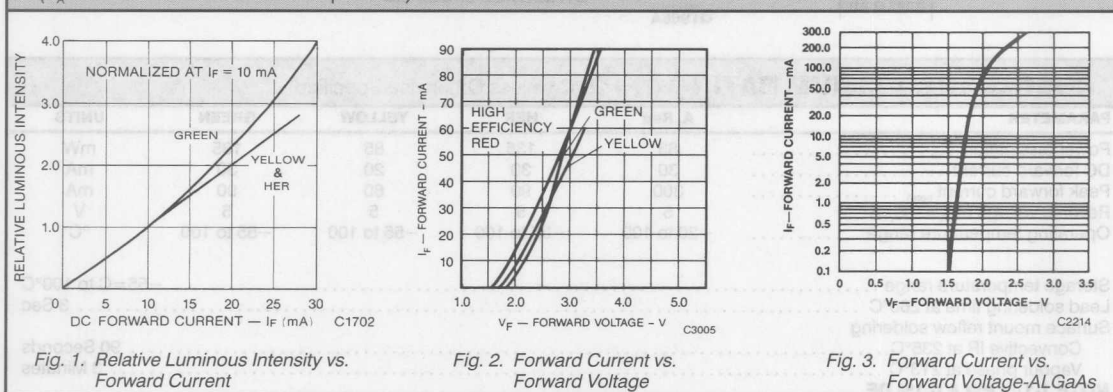
Thermal resistance $\theta_{JUNC \text{ to pin}}$	HLMP-Q150	220 $^\circ\text{C}/\text{W}$
	HLMP-7000/19/40	120 $^\circ\text{C}/\text{W}$

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage - V_F					
HLMP-Q150		1.6	1.8	V	$I_F = 1 \text{ mA}$
HLMP-7000	1.5	1.8	3.0	V	$I_F = 10 \text{ mA}$
HLMP-7019/40	1.5	2.0	3.0	V	$I_F = 10 \text{ mA}$
Reverse voltage - V_R					
HLMP-Q150	5	15		V	$I_R = 100 \mu\text{A}$
HLMP-7000	5	30		V	$I_R = 100 \mu\text{A}$
HLMP-7019/40	5	50		V	$I_R = 100 \mu\text{A}$
Viewing angle - $2\theta_{1/2}$		90		Degree	
Luminous intensity - I_L					
HLMP-Q150	1.0	1.8		mcd	$I_F = 1 \text{ mA}$
HLMP-7000/19/40	0.4	0.6		mcd	$I_F = 2 \text{ mA}$
Peak wavelength					
HLMP-Q150		645		nm	
HLMP-7000		635		nm	
HLMP-7019		583		nm	
HLMP-7040		565		nm	
Dominant wavelength					
HLMP-Q150		637		nm	
HLMP-7000		626		nm	
HLMP-7019		585		nm	
HLMP-7040		569		nm	
Spectral line half width					
HLMP-Q150		20		nm	
HLMP-7000/19/40		35		nm	
Capacitance - C					
HLMP-Q150		30		pF	$V_F = 0, F = 1 \text{ MHz}$
HLMP-7000/19/40		15		pF	$V_F = 0, F = 1 \text{ MHz}$

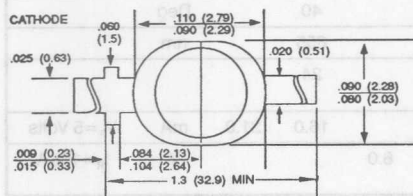
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)



**RED MR5000/5010/5020
YELLOW MR5310
GREEN MR5410**

PACKAGE DIMENSIONS



DESCRIPTION

These T-3/4 LED lamps contain an integral resistor which is in series with the emitter chip. This construction allows for operation in circuits with 5 volt supply voltage; without the use of an external current limiting resistor. Color tinted, diffused epoxy packages are used for all lamps in this group.

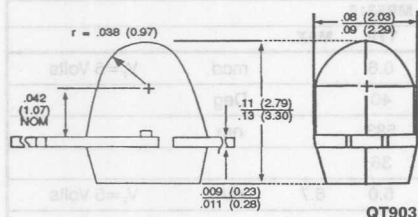
FEATURES

Applications include circuit board status indication; especially in TTL circuits. They allow for savings in component/assembly costs. The lamps are compatible with vapor phase reflow surface mount and conventional solder assembly.

- Integral Current Limiting Resistor
(No external resistor required)
- Operates with 5 Volt Supply
- All Colors
 - MR5000/5010/5020 Red Diffused
 - MR5310 Yellow Diffused
 - MR5410 Green Diffused
- Subminiature Package
- Solid-State Reliability

NOTES:

1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCES $\pm .010$ INCH UNLESS SPECIFIED



PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR
MR5000	Red	Red Diffused
MR5010	Red	Red Diffused
MR5020	Red	Red Diffused
MR5310	Yellow	Yellow Diffused
MR5410	Green	Green Diffused

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25°C Unless Otherwise Specified)

RED										UNITS	TEST CONDITION	
PARAMETER	SYMBOL	MR5000			MR5010			MR5020				
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
Axial Luminous Intensity	I _v	0.3	0.6		0.6	1.2		1.0	2.0		mcd	V _F =5 Volts
Total Viewing Angle	2θ _{1/2}	40			40			40			Deg	
Peak Wavelength	λ _p	655			655			655			nm	
Spectral Line Halfwidth	Δ λ _{1/2}	24			24			24				
Forward Current	I _F	3.0			6.0			16.0			mA	V _F =5 Volts
Reverse Breakdown Voltage	V _{BR}	6.0			6.0			6.0			V	I _R =10μA

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25°C Unless Otherwise Specified)

PARAMETER	SYMBOL	GREEN			YELLOW			UNITS	TEST CONDITION	
		MR5410			MR5310					
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.			
Axial Luminous	I _v	0.3	0.5		0.3	0.6		mcd	V _F =5 Volts	
Total Viewing Angle	2θ _{1/2}	40			40			Deg		
Peak Wavelength	λ _p	565			583			nm		
Spectral Line	Δ λ _{1/2}	28			36					
Forward Current	I _F	5.0			6.7	5.0	6.7	mA	V _F =5 Volts	
Reverse Breakdown Voltage	V _{BR}	6.0			6.0				V	I _R =10μA

ABSOLUTE MAXIMUM RATINGS (TA = 25°C Unless Otherwise Specified)

	RED	GREEN	YELLOW
DC Forward Voltage	6 Volts	6 Volts	6 Volts
Reverse Voltage (I _R =10μA)	6 Volts	6 Volts	6 Volts
Operating Temperature Range	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Storage Temperature Range	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Lead Soldering Temperature	260°C for 3 Secs	260°C for 3 Secs	260°C for 3 Secs

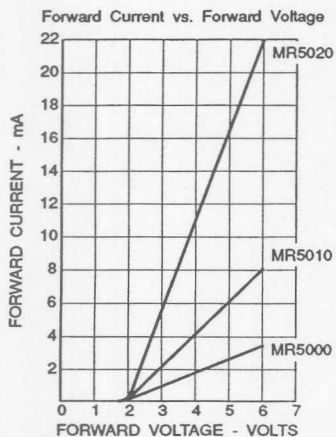
MR5000/5010/5020 MR5310 MR5410

TYPE	COLOR	LENS COLOR
MR5000	Red	Red Diffused
MR5010	Red	Red Diffused
MR5020	Red	Red Diffused
MR5310	Yellow	Yellow Diffused
MR5410	Green	Green Diffused

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

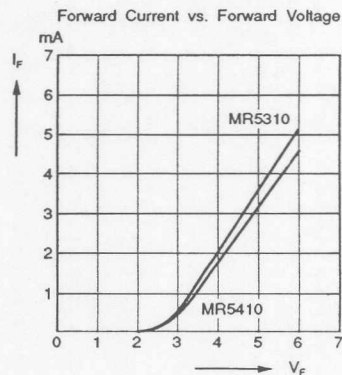
(TA = 25°C Unless Otherwise Specified)

Red MR5000/5010/5020



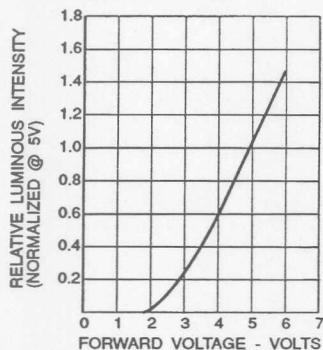
QT903-20

**Green MR5410
Yellow MR5310**



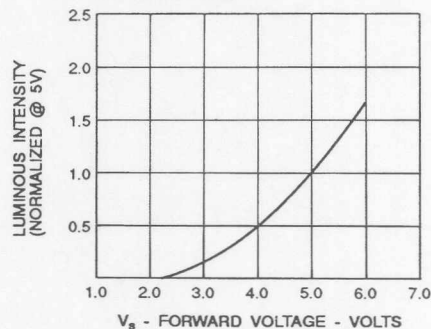
QT903-21

**Relative Luminous Intensity
vs. Forward Voltage**



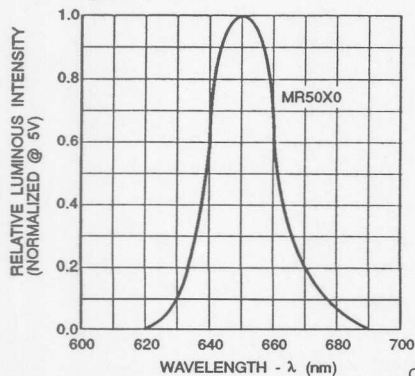
QT903-22

**Relative Luminous Intensity
vs. Forward Voltage**



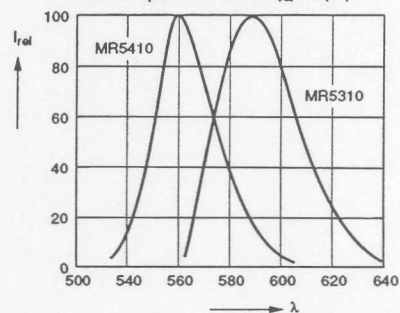
QT903-23

Spectral Distribution



QT903-24

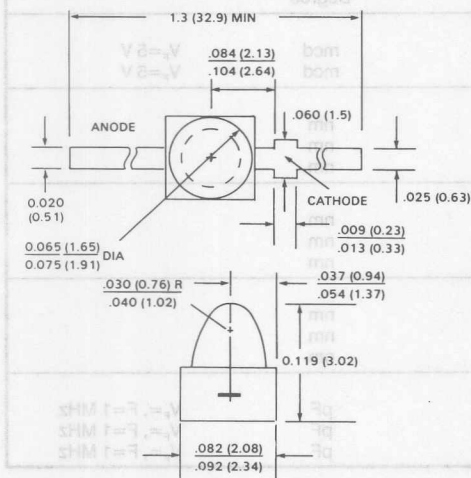
Relative Spectral Emission $I_{rel} = f(\lambda)$



QT903-25

**HIGH EFFICIENCY RED HLMP-6600/20
YELLOW HLMP-6700/20
HIGH EFFICIENCY GREEN HLMP-6800/20**

PACKAGE DIMENSIONS

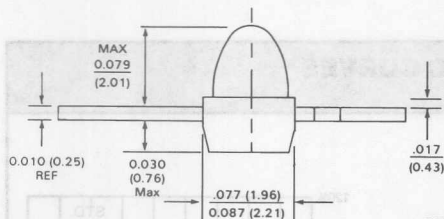


DESCRIPTION

These T- $\frac{3}{4}$ square based LEDs contain an integral resistor which is in series with the emitter chip. This construction allows for the operation in circuits with 5V supply voltage; without the use of an external resistor. Color tinted, diffused epoxy packages are used for these lamps.

FEATURES

- Integral current limiting resistor.
- TTL compatible
- Wide viewing angle
- Solid-state reliability
- SMT lead formings and T&R available



NOTES:

1. ALL DIMENSIONS IN INCHES (mm)
2. TOLERANCE ARE $\pm .010$ INCH UNLESS OTHERWISE SPECIFIED

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ unless otherwise specified)

PARAMETER	HER	YELLOW	GREEN	UNITS
Power dissipation	135	85	135	mW
DC forward voltage	6	6	6	V
Lead soldering time at	3	3	3	Sec
Surface mount reflow soldering				
Convective IR at 235°C				90 Seconds
Vapour phase at 213°C				3 Minutes
Operating temperature range				-40°C to 85°C
Storage temperature range				-55°C to 100°C

TYPICAL THERMAL CHARACTERISTICS

Thermal resistance θ_{JA}	120°C/W
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ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward current - I_F					
HLMP-6600/6700/6800		9.6	13.0	mA	$V_F = 5\text{ V}$
HLMP-6620/6720/6820		3.5	5.0	mA	$V_F = 5\text{ V}$
Reverse voltage - V_R	5	30		V	$I_R = 100\mu\text{A}$
Viewing angle - 2θ		90		Degree	
Luminous intensity - I_v					
HLMP-6600/6700/6800	1.3	5.0		mcd	$V_F = 5\text{ V}$
HLMP-6620/6720/6820	0.8	2.0		mcd	$V_F = 5\text{ V}$
Peak wavelength				nm	
HLMP-6600/20		635		nm	
HLMP-6700/20		583		nm	
HLMP-6800/20		565		nm	
Dominant wavelength				nm	
HLMP-6600/20		626		nm	
HLMP-6700/20		585		nm	
HLMP-6800/20		569		nm	
Spectral line half-width				nm	
HLMP-6600/20		40		nm	
HLMP-6700/20		36		nm	
HLMP-6800/20		28		nm	
Capacitance - C				pF	$V_F = , F = 1\text{ MHz}$
HLMP-6600/20		11		pF	$V_F = , F = 1\text{ MHz}$
HLMP-6700/20		15		pF	$V_F = , F = 1\text{ MHz}$
HLMP-6800/20		18		pF	$V_F = , F = 1\text{ MHz}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

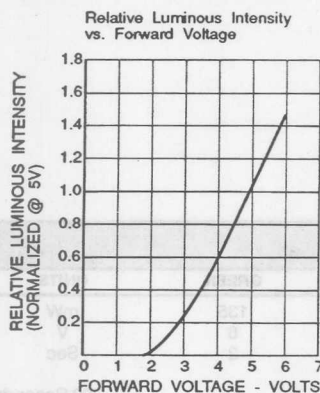


Fig. 1. Relative Luminous Intensity vs. Forward Voltage

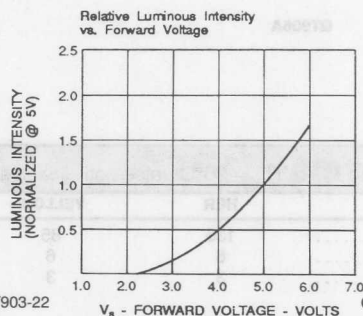


Fig. 2. Relative Luminous Intensity vs. Forward Voltage

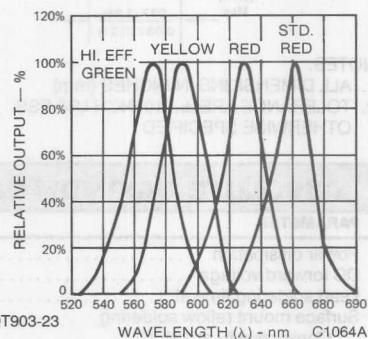
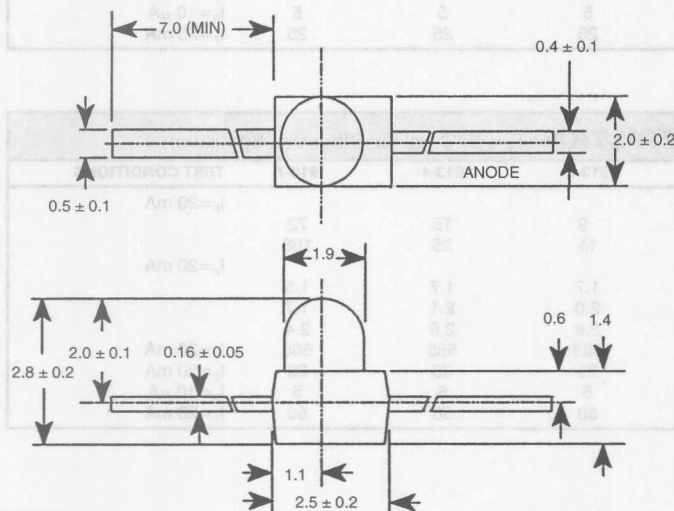


Fig. 3. Spectral Distribution

RED QTLP913-2 RED DIFFUSED
YELLOW QTLP913-3 YELLOW DIFFUSED
GREEN QTLP913-4 GREEN DIFFUSED
AlGaAs/RED QTLP913-7 RED DIFFUSED

RED QTLP912-2 CLEAR
YELLOW QTLP912-3 CLEAR
GREEN QTLP912-4 CLEAR
AlGaAs/RED QTLP912-7 CLEAR

PACKAGE DIMENSIONS



ST1669

DESCRIPTION

These subminiature LED lamps are intended for high volume, low cost status indication on PCBs, and for backlighting keyboards and switches. They are compatible with vapor phase reflow or wave solder surface mount equipment. Available in either clear, or tinted diffused lens and a choice of "Yoke", "Z-Bend", or "Gull-Wing" lead bends. Tape and reel options are also available.

FEATURES

- Subminiature package.
- Low package profile.
- Choice of clear or tinted diffused lens.
- Three lead bend options for surface mounting.

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

	Red	Green	Yellow	AlGaAs (Red)
DC forward current (I_f)	30 mA	30 mA	20 mA	40 mA
Operating temperature range		-40°C to +85°C		
Storage temperature range		-40°C to +100°C		
Lead soldering time (at 1/16 inch from the bottom of lamp)		5 seconds @ 260°C		
Peak forward current (at $f = 1.0$ KHz, Duty factor = 1/10)	160 mA	160 mA	160 mA	200 mA
Power dissipation (P_d)	100 mW	100 mW	85 mW	110 mA
Recommended operating current (I_f , Rec)			20 mA	

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER QTLP-	912-2	912-3	912-4	912-7	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 20\text{ mA}$
minimum	48	18	30	113	
typical	80	30	50	170	
Forward voltage (V_F)					$I_F = 20\text{ mA}$
minimum	1.7	1.7	1.7	1.7	
typical	2.0	2.0	2.1	2.0	
maximum	2.8	2.8	2.8	2.8	
Peak wavelength (nm)	640	585	565	660	$I_F = 20\text{ mA}$
Spectral line half width (nm)	45	35	30	20	$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)	5	5	5	5	$I_R = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	25	25	25	25	$I_F = 20\text{ mA}$

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER QTLP-	913-2	913-3	913-4	913-7	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 20\text{ mA}$
minimum	24	9	15	72	
typical	40	15	25	108	
Forward voltage (V_F)					$I_F = 20\text{ mA}$
minimum	1.7	1.7	1.7	1.5	
typical	2.0	2.0	2.1	1.7	
maximum	2.8	2.8	2.8	2.4	
Peak wavelength (nm)	640	585	565	660	$I_F = 20\text{ mA}$
Spectral line half width (nm)	45	35	30	20	$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)	5	5	5	5	$I_R = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	50	50	50	50	$I_F = 20\text{ mA}$

QTLP913-2/3/4/7 QTLP912-2/3/4/7

Part Number	QTLP912-2	QTLP912-3	QTLP912-4	QTLP912-7
Wavelength (nm)	640	585	565	660
Peak Wavelength (nm)	640	585	565	660
Forward Current (I_F)	20 mA	20 mA	20 mA	20 mA
Reverse Current (I_R)	10 μA	10 μA	10 μA	10 μA
Forward Voltage (V_F)	2.0 V	2.0 V	2.1 V	2.0 V
Reverse Voltage (V_R)	5 V	5 V	5 V	5 V
Viewing Angle ($^\circ$)	25	25	25	25
Operating Temperature Range	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C
Storage Temperature Range	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C	-40°C to +100°C
Lead Soldering Time	5 seconds @ 250°C	5 seconds @ 250°C	5 seconds @ 250°C	5 seconds @ 250°C
Lead Soldering Temp	250°C	250°C	250°C	250°C
Peak Forward Current ($I_{F(pk)}$)	100 mA	100 mA	100 mA	100 mA
Power Dissipation (P_D)	100 mW	100 mW	100 mW	100 mW
Recommended Operating Current ($I_{F(Rec)}$)	20 mA	20 mA	20 mA	20 mA

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$)

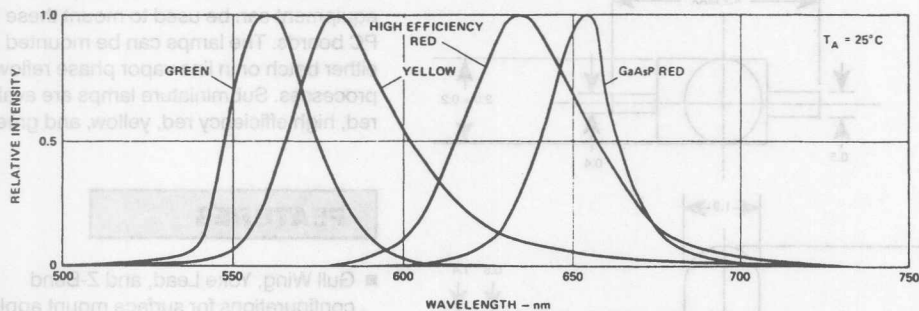


Fig. 1 Relative Intensity Vs. Wavelength

ST1717

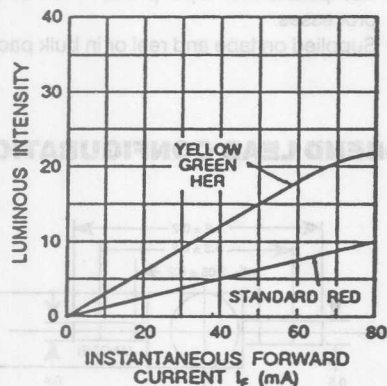


Fig. 2. Relative Luminous Intensity Vs. DC Forward Current

ST1718

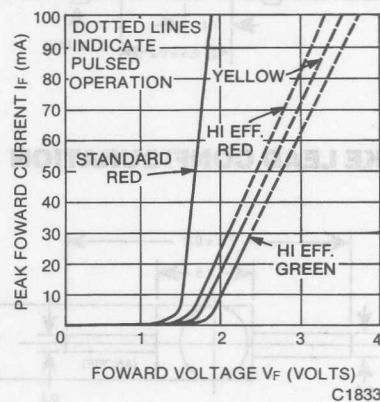


Fig. 3. Forward Current Vs. Forward Voltage

C1833

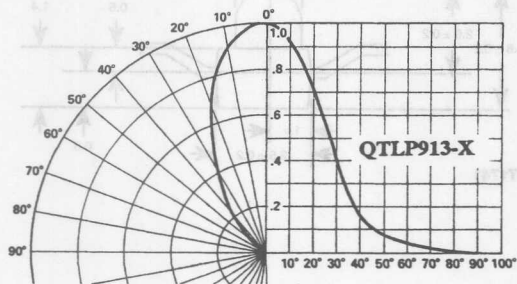


Fig. 4. Relative Luminous Intensity vs. Angular Displacement

ST1720

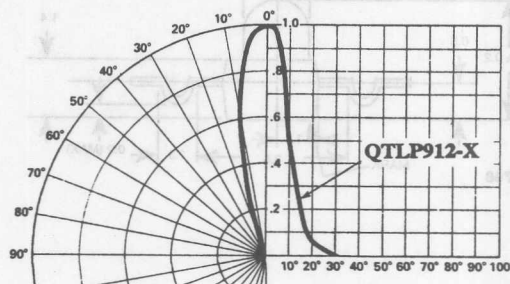


Fig. 5. Relative Luminous Intensity vs. Angular Displacement

ST1721

SURFACE MOUNT OPTIONS FOR QTLP91X-X SUBMINIATURE T-3/4 (1.9 mm) GULL WING/YOKE/Z-BEND LEADS

LEAD BEND OPTIONS

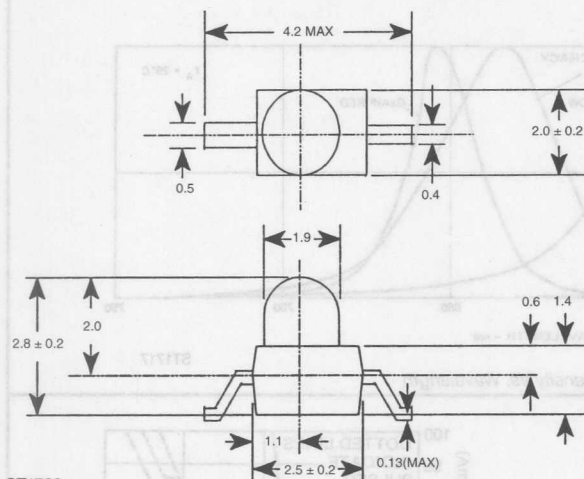
DESCRIPTION

GULL WING LEAD CONFIGURATION

These subminiature lamps are encapsulated in an axial lead package. Either a clear or diffused lenses are available. Automatic placement equipment can be used to mount these LEDs on PC boards. The lamps can be mounted using either batch or in line vapor phase reflow solder processes. Subminiature lamps are available in red, high efficiency red, yellow, and green.

FEATURES

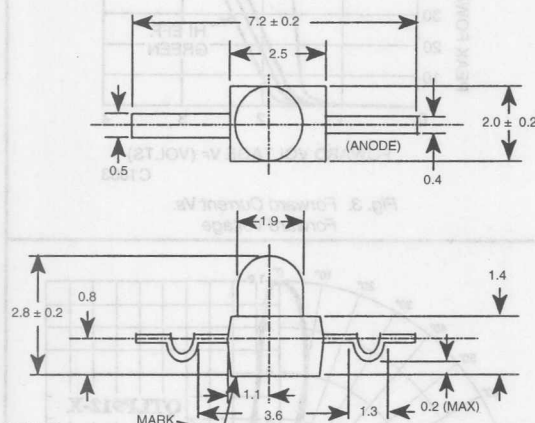
- Gull Wing, Yoke Lead, and Z-Bend configurations for surface mount applications.
- Compatible with automatic placement equipment
- Compatible with vapor phase reflow solder processes.
- Supplied on tape and reel or in bulk packaging



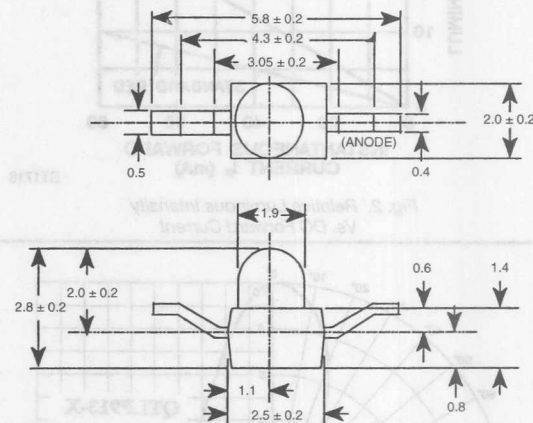
ST1739

YOKE LEAD CONFIGURATION

Z-BEND LEAD CONFIGURATION



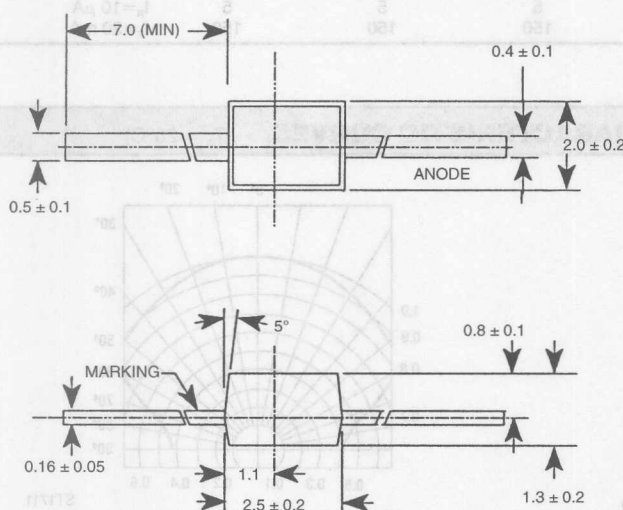
ST1740



ST1741

RED QTLP282-2 CLEAR
YELLOW QTLP282-3 CLEAR
GREEN QTLP282-4 CLEAR
AlGaAs/RED QTLP282-7 CLEAR

PACKAGE DIMENSIONS



ST1709

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAXIMUM

DESCRIPTION

These subminiature LED lamps are intended for high volume, low cost status indication on PCBs, and for backlighting keyboards and switches. They are compatible with vapor phase reflow or wave solder surface mount equipment. Available in "Gull-Wing" lead bend configuration. They have clear, flat lenses. Tape and reel options are also available.

FEATURE

- Subminiature package
- Flat package profile
- Wide viewing angle
- Lead bend options for surface mounting

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ unless otherwise specified)

PART NUMBER QTLP-	282-2	282-3	282-4	282-7
DC forward current (I_f)	30 mA	20 mA	30 mA	40 mA
Operating temperature range		-40°C to +85°C		
Storage temperature range		-40°C to +100°C		
Lead soldering time (at 1/16 inch (1.6 mm) from the bottom of lamp)		5 seconds @ 260°C		
Peak forward current (at $f = 1.0$ KHz, Duty factor = 1/10)	160 mA	160 mA	160 mA	200 mA
Power dissipation (P_d)	100 mW	85 mW	100 mW	110 mA
Recommended operating current (I_f Rec)		20 mA		

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER	282-2	282-3	282-4	282-7	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 20\text{ mA}$
minimum	1.5	3.5	1.0	11	
typical	5.6	6.0	5.6	17	
Forward voltage (V_F)					$I_F = 20\text{ mA}$
minimum	1.7	1.7	1.7	1.7	
typical	2.0	2.0	2.1	2.0	
maximum	2.8	2.8	2.8	2.8	
Peak wavelength (nm)	640	585	565	660	$I_F = 20\text{ mA}$
Spectral line half width (nm)	45	35	30	20	$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)	5	5	5	5	$I_R = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	150	150	150	150	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

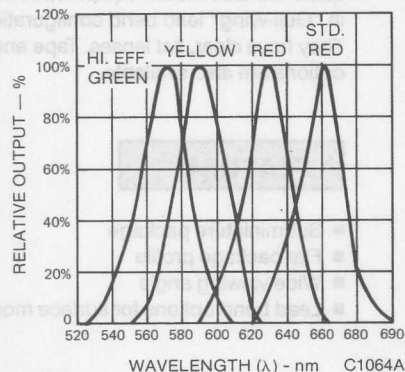


Fig. 1. Relative Intensity vs. Wavelength

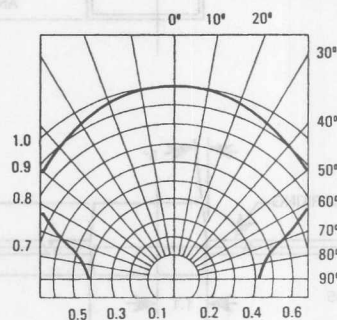


Fig. 2. Relative Luminous Intensity vs. Angular Displacement

ST1711

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$)

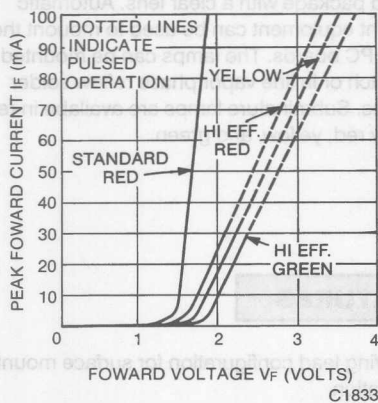


Fig. 3. Forward Current vs. Forward Voltage

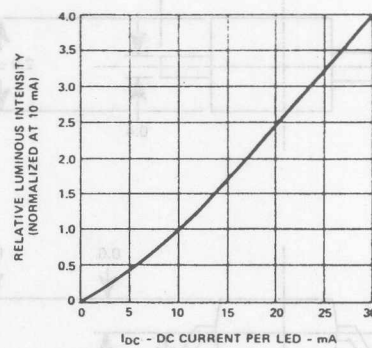


Fig. 4. Relative Luminous Intensity vs. DC Forward Current

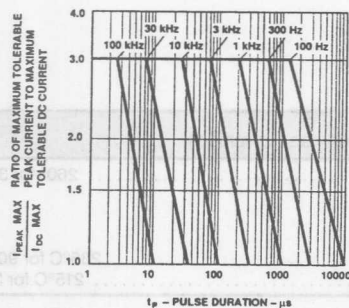


Fig. 5. Maximum Peak Current vs. Pulse Duration

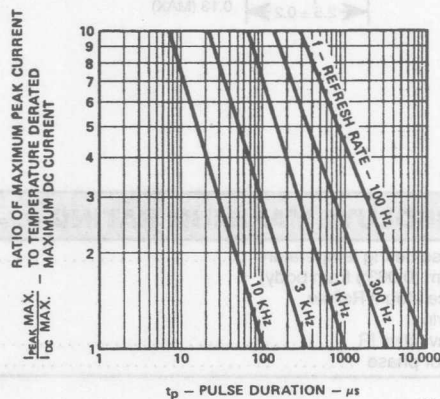
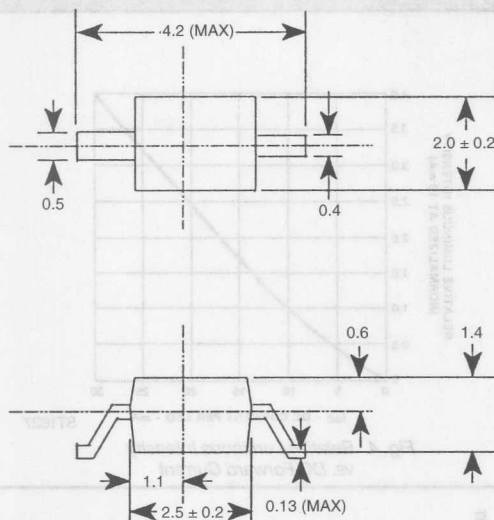


Fig. 6. Maximum Peak Current Vs. Pulse Duration (AlGaAs Red)

SURFACE MOUNT OPTION FOR QTLP282-X FLAT TYPE LED LAMP GULL WING LEAD CONFIGURATION

LEAD BEND OPTIONS



DESCRIPTION

These flat package LED lamps are encapsulated in an axial lead package with a clear lens. Automatic placement equipment can be used to mount these LEDs on PC boards. The lamps can be mounted using either batch or in line vapor phase reflow solder processes. Subminiature lamps are available in red, high efficiency red, yellow, and green.

FEATURES

- Gull Wing lead configuration for surface mount application
- Compatible with automatic placement equipment
- Compatible with vapor phase reflow solder processes.
- Supplied on tape and reel or in bulk packaging

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

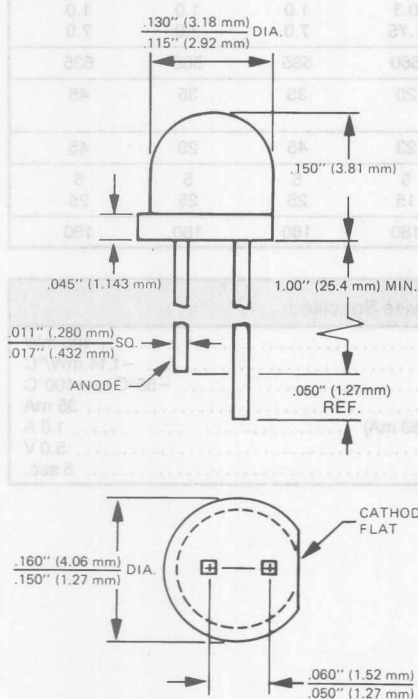
Wave soldering temperature (1.6 mm (0.063") from body)	260° for 3 seconds
Surface Mount Reflow	
Soldering:	
Convective IR	235°C for 90 seconds
Vapor phase	215°C for 3 minutes

ABSOLUTE MAXIMUM SOLDER RATINGS AND ELECTRICAL/OPTICAL CHARACTERISTICS

The absolute maximum ratings and electrical/optical specifications are identical to the basic catalogue device, except for the vapor phase soldering rating as specified above.

**STANDARD RED MV5077C HIGH EFFICIENCY GREEN MV5477C
YELLOW MV5377C HIGH EFFICIENCY RED MV5777C**

PACKAGE DIMENSIONS



NOTE: TOLERANCE $\pm .010"$
UNLESS SPECIFIED

C1132A

DESCRIPTION

These solid state indicators offer a low profile T-1 package. The High Efficiency Red, Green and Yellow devices are made with a gallium arsenide phosphide on gallium phosphide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

FEATURES

- Square leads (will fit into .020-inch (.508 mm) diameter holes)
- Compact size
- Very wide viewing angle
- Long life, rugged
- Mount on approximately 3/16-inch (4.72 mm) centers
- Tinted diffused

PHYSICAL CHARACTERISTICS

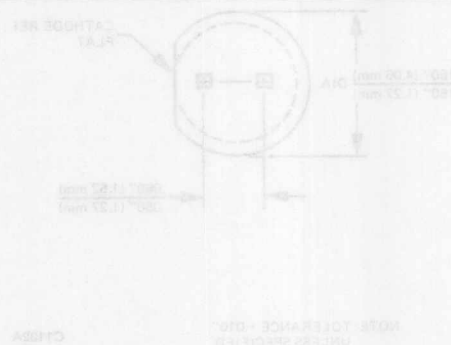
TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE STYLE
MV5077C	Standard Red	Red Diffused	Wide Beam	Low Profile
MV5377C	Yellow	Yellow Diffused	Wide Beam	Low Profile
MV5477C	High Efficiency Green	Green Diffused	Wide Beam	Low Profile
MV5777C	Red	Red Diffused	Wide Beam	Low Profile

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV5077C	MV5377C	MV5477C	MV5777C
Forward voltage	typ.	V_F	$I_F = 20\text{ mA}$	V	1.6	2.1	2.2	2.0
	max.		$I_F = 20\text{ mA}$	V	2.0	3.0	3.0	3.0
Luminous Intensity	min.	I_V	$I_F = 20\text{ mA}$	mcd	0.3	1.0	1.0	1.0
	typ.		$I_F = 20\text{ mA}$	mcd	1.75	7.0	7.0	7.0
Peak wavelength		λ_p	$I_F = 20\text{ mA}$	nm	660	585	565	635
Spectral line half width			$I_F = 20\text{ mA}$	nm	20	35	35	45
Capacitance	typ.	C	$V = 0$	pF	23	45	20	45
Reverse voltage	min.	V_R	$I_R = 100\text{ }\mu\text{A}$	V	5	5	5	5
	typ.		$I_R = 100\text{ }\mu\text{A}$	V	15	25	25	25
Viewing angle (total)	(Fig. 3)	$2\theta_{1/2}$		degrees	180	180	180	180

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	105 mW
Derate linearly from 25°C	$-1.14\text{ mW}/^\circ\text{C}$
Storage and operating temperature	-55°C to $+100^\circ\text{C}$
Continuous forward current (MV5377C=20 mA)	35 mA
Peak forward current (μsec pulse 0.3% duty cycle) (MV5477C=90 mA) (MV5377C=60 mA)	1.0 A
Reverse voltage	5.0 V
Lead soldering time at 260°C (See Note 1)	5 sec.



MV5077C MV5377C MV5477C MV5777C

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE STYLE
MV5077C	Standard Red	Red Diffused	Wide Beam	Low Profile
MV5377C	Yellow	Yellow Diffused	Wide Beam	Low Profile
MV5477C	High Efficiency Green	Green Diffused	Wide Beam	Low Profile
MV5777C	Red	Red Diffused	Wide Beam	Low Profile

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

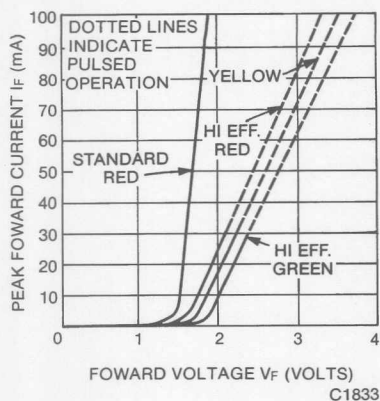


Fig. 1. Forward Current vs.
Forward Voltage

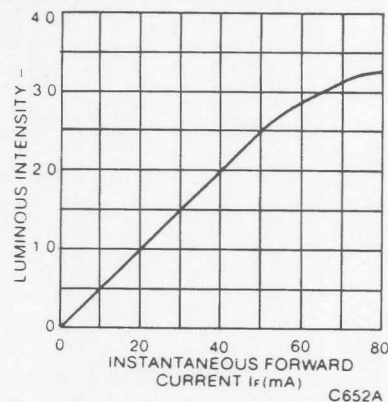


Fig. 2. Luminous Intensity vs.
Forward Current

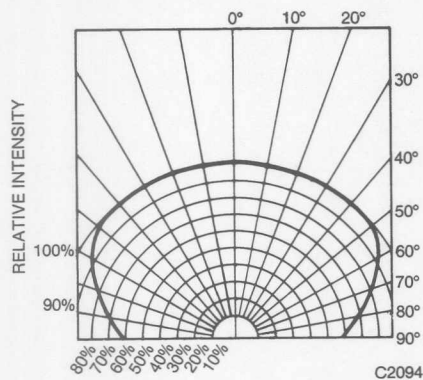


Fig. 3. Spatial Distribution

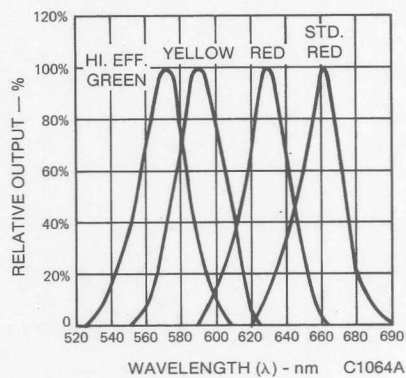


Fig. 4. Spectral Distribution

NOTES

1. The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.

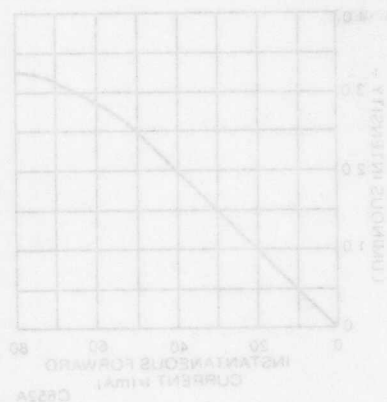


Fig. 2. Forward Current vs. Instantaneous Forward Current

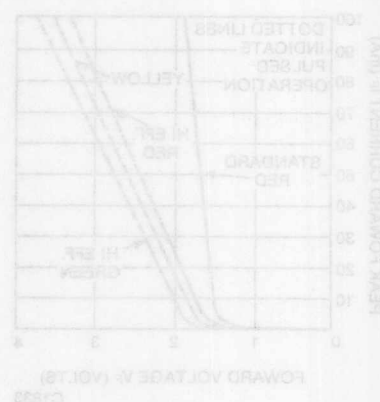


Fig. 1. Forward Voltage vs. Forward Current

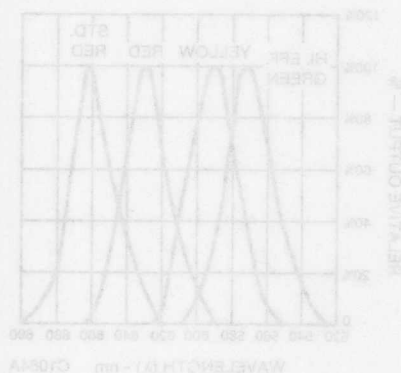


Fig. 4. Spectral Distribution

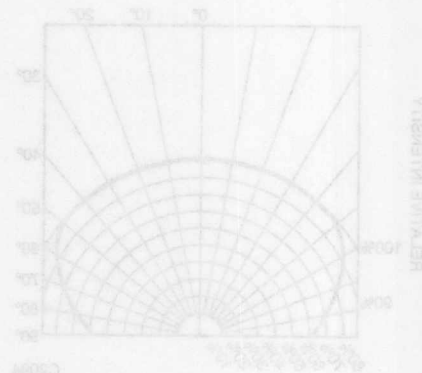
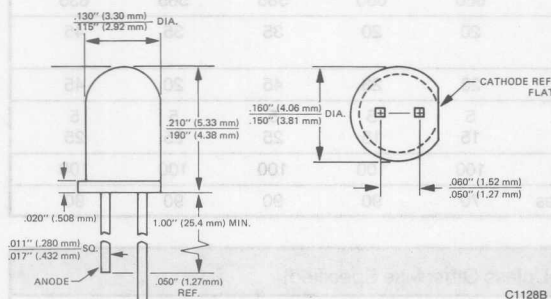


Fig. 3. Spot Distribution

1. The leads of the device were immersed in molten solder at 250°C for a period of 10 seconds (1.5 inch (1.5 inch) from the body of the device per MIL-S-750 with a dwell time of 2 seconds.

YELLOW MV5374C
STANDARD RED MV5074C HIGH EFFICIENCY GREEN MV5474C
STANDARD RED MV5075C HIGH EFFICIENCY RED MV5774C

PACKAGE DIMENSIONS



DESCRIPTION

These solid state indicators offer a variety of color selection. The High Efficiency Red, Green and Yellow devices are made with a gallium arsenide phosphide on gallium phosphide. All are encapsulated in epoxy packages. Their small size (approximately T-1 size), good viewing angle, and small square leads contribute to their versatility as all purpose indicators.

FEATURES

- Square leads (will fit into .020-inch (.508mm) diameter hole)
- Compact size
- Long life, rugged
- 1-inch (25.4 mm) minimum lead length
- Mount on approximately 3/16-inch (4.72 mm) centers

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE STYLE
MV5074C	Standard Red	Red Clear	Narrow Beam	High Profile
MV5075C	Standard Red	Red Diffused	Wide Beam	High Profile
MV5374C	Yellow	Yellow Diffused	Wide Beam	High Profile
MV5474C	High Efficiency Green	Green Diffused	Wide Beam	High Profile
MV5774C	High Efficiency Red	Red Diffused	Wide Beam	High Profile

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV5074C	MV5075C	MV5374C	MV5474C	MV5774C
Forward voltage	typ.	V_F	$I_F = 20\text{ mA}$	V	1.6	1.6	2.1	2.2	2.0
	max.		$I_F = 20\text{ mA}$	V	2.0	2.0	3.0	3.0	3.0
Luminous Intensity	min.	I_V	$I_F = 20\text{ mA}$	mcd	0.7	0.6	1.5	1.2	1.5
	typ.		$I_F = 20\text{ mA}$	mcd	2.5	1.5	9.0	9.0	9.0
Peak wavelength		λ_p	$I_F = 20\text{ mA}$	nm	660	660	585	565	635
Spectral line half width			$I_F = 20\text{ mA}$	nm	20	20	35	35	45
Capacitance	typ.	C	V=0	pF	23	23	45	20	45
Reverse voltage	min.	V_{BR}	$I_R = 100\text{ }\mu\text{A}$	V	5	5	5	5	5
	typ.		$I_R = 100\text{ }\mu\text{A}$	V	15	15	25	25	25
Reverse current	max.		$V_R = 5.0\text{ V}$	μA	100	100	100	100	100
Viewing angle (total)		20 °	See Fig. 3	degrees	70	90	90	90	90

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	105 mW
Derate linearly from 25°C	$-1.14\text{ mW}/^\circ\text{C}$
Storage and operating temperature	-55°C to $+100^\circ\text{C}$
Lead soldering time at 260°C (See Note 1)	5 sec.
Continuous forward current (MV5374C=20 mA)	35 mA
Peak forward current (μsec pulse 0.3% duty cycle) (MV5474C=90 mA) (MV5374C=60 mA)	1.0 A
Reverse voltage	5.0 V

MV5074C MV5075C MV5374C MV5474C MV5774C

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	PACKAGE STYLE
MV5074C	Standard Red	Red Clear	Narrow Beam	High Profile
MV5075C	Standard Red	Red Diffused	Wide Beam	High Profile
MV5374C	Yellow	Yellow Diffused	Wide Beam	High Profile
MV5474C	High Efficiency Green	Green Diffused	Wide Beam	High Profile
MV5774C	High Efficiency Red	Red Diffused	Wide Beam	High Profile

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

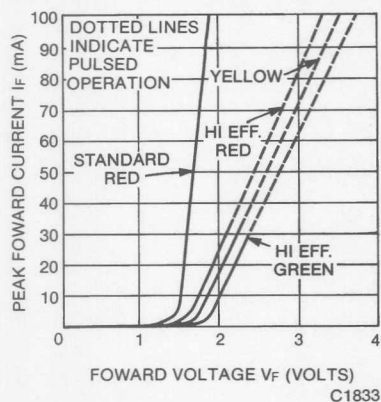


Fig. 1. Forward Current vs. Forward Voltage

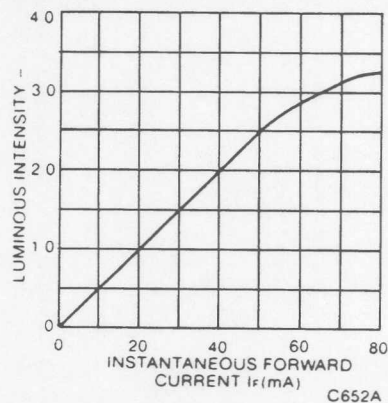


Fig. 2. Luminous Intensity vs. Forward Current

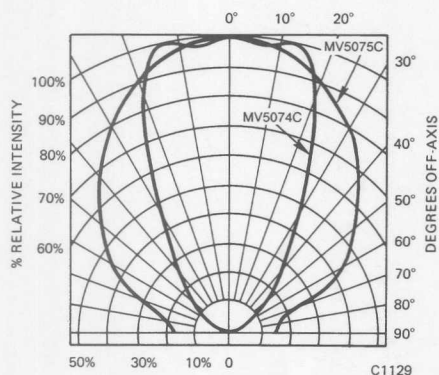


Fig. 3. Spatial Distribution

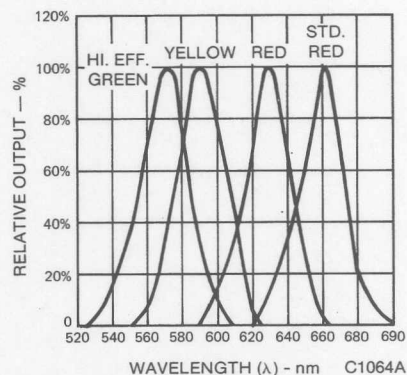


Fig. 4. Spectral Distribution

NOTES

1. The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.

THE EFFECT OF FORWARD CURRENT ON INSTANTANEOUS CURRENT

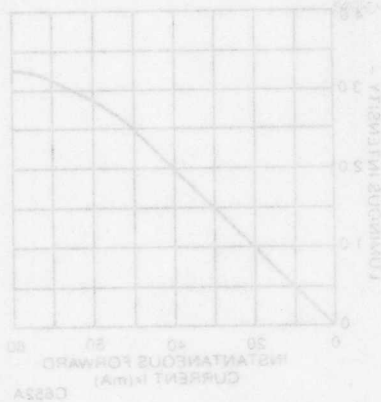


Fig. 2. Luminous Intensity vs. Forward Current

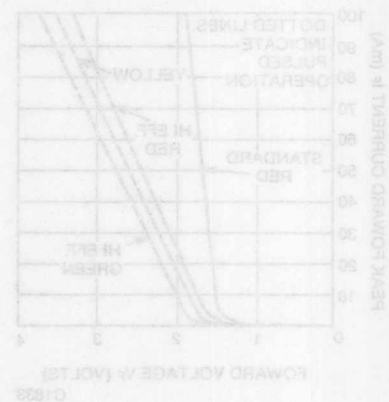


Fig. 1. Forward Current vs. Forward Voltage

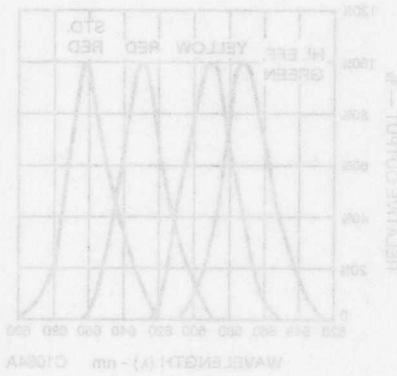


Fig. 4. Spectral Distribution

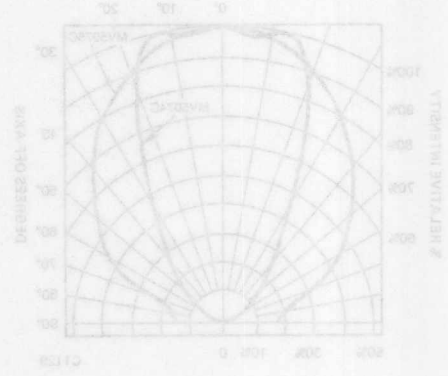
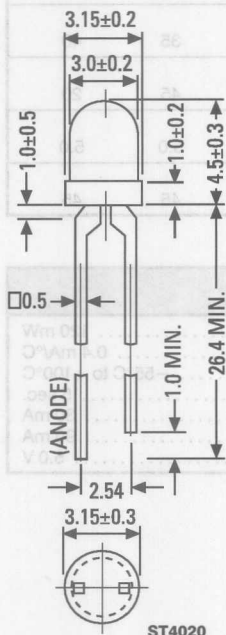


Fig. 3. Spectral Distribution

1. The leads of the device were immersed in molten solder at 250°C to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-1200 with a dwell time of 5 seconds.

**YELLOW MV5362X TINTED, HLMP-1440, MV5360 PALE TINT
HIGH EFFICIENCY GREEN MV5462X TINTED, HLMP-1540, MV5460 PALE TINT
HIGH EFFICIENCY RED MV5762X TINTED, HLMP-1340, MV5760 PALE TINT**

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These solid state indicators offer a variety of color selection. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. All are encapsulated in epoxy packages and have clear lenses. Their small size, wide viewing angle, and small square leads contribute to their versatility as all-purpose indicators. All types are tinted to aid identification.

FEATURES

- Standard and Ultrabright devices
- Clear tinted lenses
- 100 mil lead spacing
- High efficiency GaP
- Versatile mounting on PC board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- T-1 diameter
- Replacement for the HLMP-1X20/1 Series
- Excellent for switch backlighting

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT	LUMINOUS INTENSITY at 25°C (med)		TEST CONDITION
			MIN.	TYP.	
Ultrabright HLMP-1440	Yellow	Pale Tint	24.0	60.0	$I_F = 20 \text{ mA}$ $I_F = 10 \text{ mA}$
MV5360 (HLMP-1420)	Yellow	Pale Tint	6.0	12.0	
MV53621	Yellow	Tinted	3.0	4.0	
MV53622	Yellow	Tinted	6.0	8.0	
Ultrabright HLMP-1540	High Efficiency Green	Pale Tint	24.0	60.0	$I_F = 20 \text{ mA}$
MV5460 (HLMP-1520)	High Efficiency Green	Pale Tint	6.0	12.0	
MV54624 (HLMP-1521)	High Efficiency Green	Tinted	6.0	12.0	
Ultrabright HLMP-1340	High Efficiency Red	Pale Orange Tint	24.0	60.0	$I_F = 20 \text{ mA}$ $I_F = 10 \text{ mA}$
MV5760 (HLMP-1320)	High Efficiency Red	Pale Orange Tint	6.0	12.0	
MV57620	High Efficiency Red	Tinted	1.5	2.0	
MV57621	High Efficiency Red	Tinted	3.0	4.0	
MV57622 (HLMP-1321)	High Efficiency Red	Tinted	6.0	12.0	

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

PARAMETER	TEST CONDITIONS	UNITS	MV5362X MV5360	MV5462X MV5460	MV5762X MV5760	HLMP-1340	HLMP-1440	HLMP-1540
Forward voltage (V_f)								
typ.	$I_f = 10 \text{ mA}$	V	2.1	2.1*	2.0	2.2*	2.2*	2.2*
max.			3.0	3.0*	3.0	3.0*	3.0*	3.0*
Peak wavelength		nm	585	565	635	635	585	565
Spectral line half width		nm	35	40	45	45	35	40
Capacitance								
typ.	$f = 1 \text{ MHz}, V = 0$	pF	45	20	45	45	45	20
Reverse voltage (V_R)								
min.	$I_R = 100 \mu\text{A}$	V	5.0	5.0	5.0	5.0	5.0	5.0
Viewing angle (total)								
typ.	See Fig. 3	degrees	45	45	45	45	45	45

* $I_f = 20 \text{ mA}$

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	120 mW
Derate linearly from 50°	0.4 mA/°C
Storage and operating temperature	-55°C to +100°C
Lead soldering time at 260°C (1/16 inch from body)	5 sec.
Continuous forward current (MV5360/MV5362X/HLMP-1440=20 mA)	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) (MV5360/MV5362X/HLMP-1440=60 mA)	90 mA
Reverse voltage	5.0 V

- Low power requirements
- Compact, rugged, lightweight
- T-1 diameter
- Replacement for the HLMP-1X201 Series
- Excellent for switch backlighting



MV5X62X HLMP-1X40 MV5X60

TEST CONDITION	MIN.	MAX.	EFFECT	COLOR	TYPE
$I_f = 20 \text{ mA}$	0.0	24.0	Pale Pink	Yellow	UltraBright/HLMP-1440
$I_f = 10 \text{ mA}$	12.0	8.0	Pale Pink	Yellow	MV5360 (HLMP-1450)
	4.0	3.0	Tinted	Yellow	MV53621
	8.0	8.0	Tinted	Yellow	MV53622
$I_f = 20 \text{ mA}$	0.0	24.0	Pale Pink	High Efficiency Green	UltraBright/HLMP-1340
	12.0	8.0	Pale Pink	High Efficiency Green	MV5460 (HLMP-1350)
	12.0	8.0	Tinted	High Efficiency Green	MV54624 (HLMP-1351)
$I_f = 20 \text{ mA}$	0.0	24.0	Pale Orange Tint	High Efficiency Red	UltraBright/HLMP-1340
$I_f = 10 \text{ mA}$	12.0	8.0	Pale Orange Tint	High Efficiency Red	MV5760 (HLMP-1350)
	2.0	1.5	Tinted	High Efficiency Red	MV57620
	4.0	3.0	Tinted	High Efficiency Red	MV57621
	12.0	8.0	Tinted	High Efficiency Red	MV57622 (HLMP-1351)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

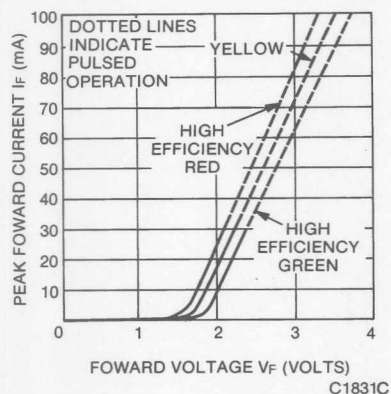


Fig. 1. Forward Current vs. Forward Voltage

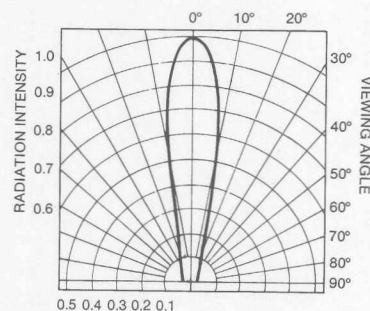


Fig. 2. Relative Luminous Intensity vs. Forward Current

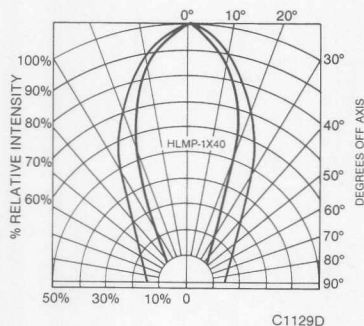


Fig. 3. Spatial Distribution

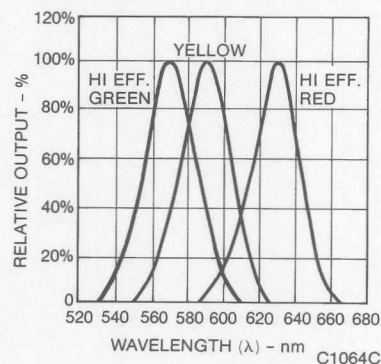


Fig. 4. Spectral Distribution

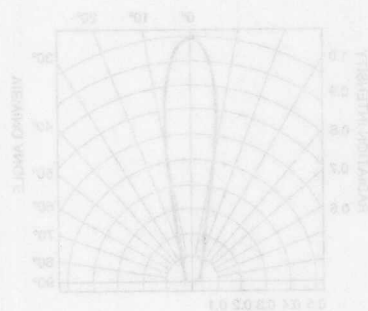


Fig. 2. Relative Luminous Intensity vs. Forward Current

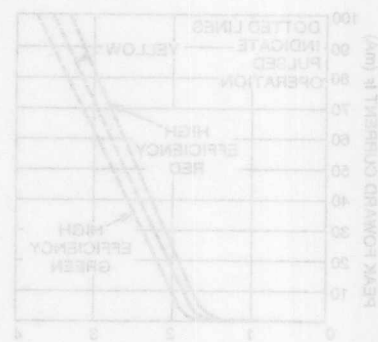


Fig. 1. Forward Current vs. Forward Voltage

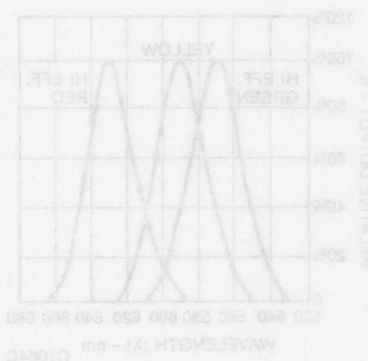


Fig. 5. Spectral Distribution

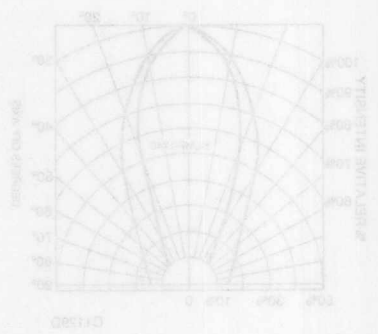
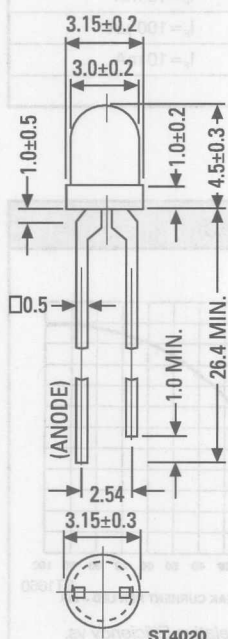


Fig. 3. Spatial Distribution

PURE GREEN HLMP-K600 TINTED
PURE GREEN HLMP-K640 CLEAR
SOFT ORANGE HLMP-K400 TINTED
SOFT ORANGE HLMP-K401 TINTED
SOFT ORANGE HLMP-K402 TINTED

PACKAGE DIMENSIONS



- NOTES:
1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These T-1 LEDs are widely used as general purpose indicators. The pure green lamps are made with a GaP LEDs on a GaP substrate. The soft orange are made with GaAsP LEDs on a GaP substrate. They are encapsulated in epoxy packages and are designed to provide superior light output and a wide viewing angle.

FEATURES

- Popular T-1½ package.
- Low drive current.
- Solid state reliability.
- Wide viewing angle.
- Choice of pure green or soft orange colors.

ABSOLUTE MAXIMUM RATING (T_A=25°C Unless Otherwise Specified)

DC forward current (I _F)	40 mA
Operating temperature range	-40°C to +85°C
Storage temperature range	-40°C to +100°C
Lead soldering time (at 1/16 inch from the bottom of lamp)	5 seconds @ 260°C
Peak forward current (I _P) (at f=1.0 KHz, Duty factor= 1/10)	200 mA
Power dissipation (P _D)	110 mW
Recommended operating current (I _F Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER HLMP-	K600	K640*	K400	K401	K402	TEST CONDITIONS
Luminous intensity (mcd)						$I_F = 10\text{ mA}$
minimum	1.0	4.2	1.0	2.0	3.0	
typical	4.5	30	4.0	5.0	6.5	
Forward voltage (V_F)						$I_F = 10\text{ mA}$
minimum			1.5	1.5	1.5	
typical	2.1	2.2	1.9	1.9	1.9	
maximum	2.7	3.0	2.4	2.4	2.4	
Peak wavelength (nm)	560	560	612	612	612	$I_F = 10\text{ mA}$
Spectral line half width (nm)	24	24	40	40	40	$I_F = 10\text{ mA}$
Reverse breakdown voltage (V_R)	5	5	5	5	5	$I_F = 100\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	90	45	90	90	90	$I_F = 10\text{ mA}$

*NOTE: HLMP-K640 test condition is $I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

Pure (Emerald) Green

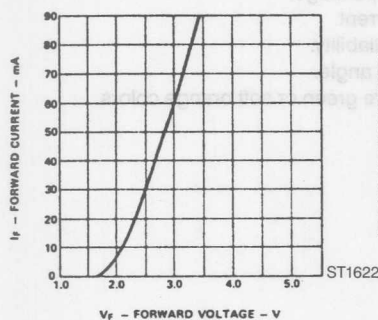


Figure 1. Forward Current vs. Forward Voltage

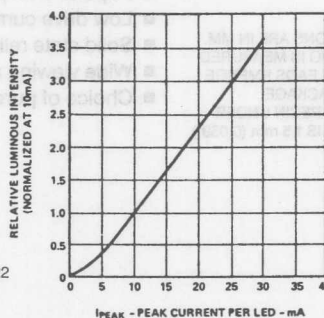


Figure 2. Relative Luminous Intensity vs. Forward Current

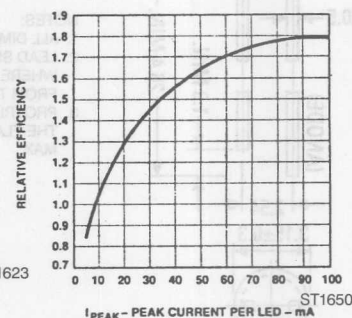


Figure 3. Relative Efficiency vs. Peak LED Current

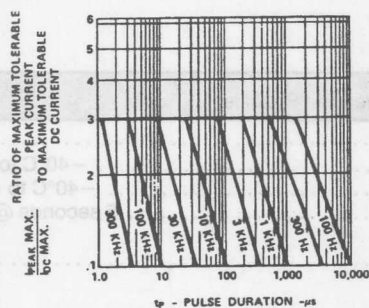


Figure 4. Maximum Peak Current vs. Pulse Duration

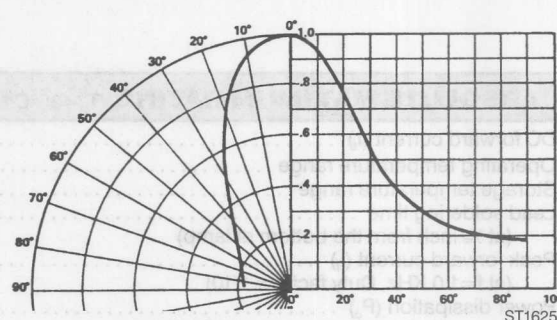


Figure 5. Relative Luminous Intensity vs. Angular Displacement

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A=25^\circ\text{C}$)

Soft Orange

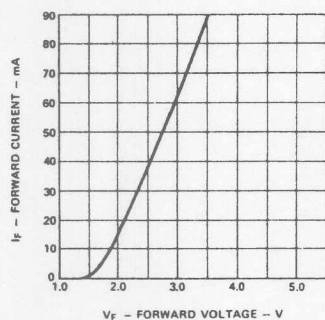


Figure 1. Forward Current vs. Forward Voltage

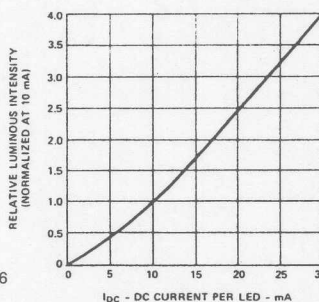


Figure 2. Relative Luminous Intensity vs. Forward Current

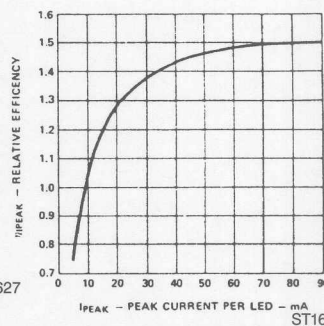


Figure 3. Relative Efficiency vs. Peak LED Current

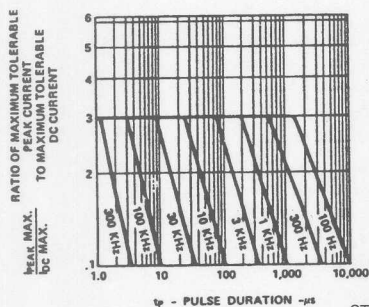


Figure 4. Maximum Peak Current vs. Pulse Duration

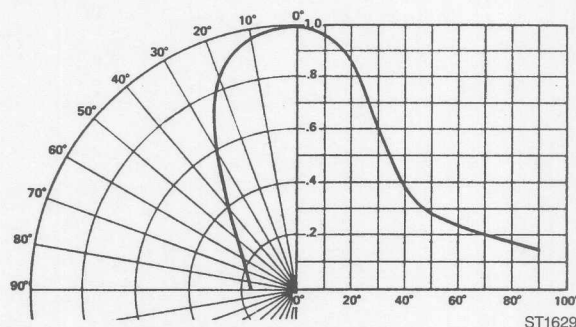


Figure 5. Relative Luminous Intensity vs. Angular Displacement

Green Orange

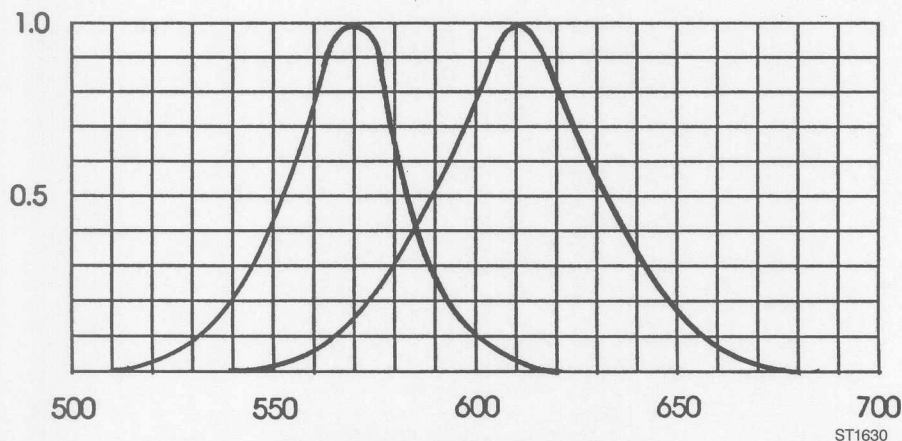
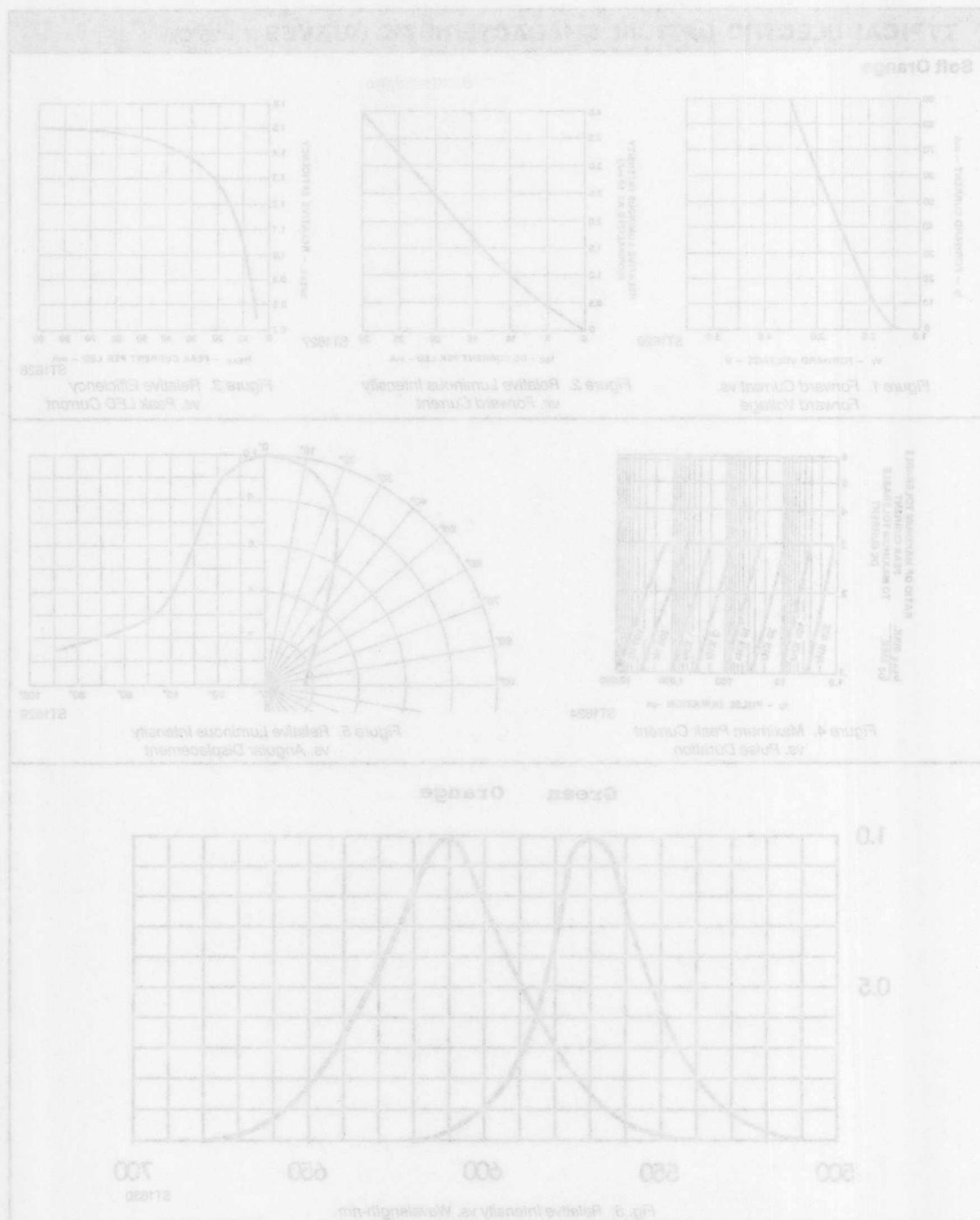


Fig. 6. Relative Intensity vs. Wavelength-nm

6

HLMP-K600 HLMP-K640 HLMP-K400 HLMP-K401 HLMP-K402

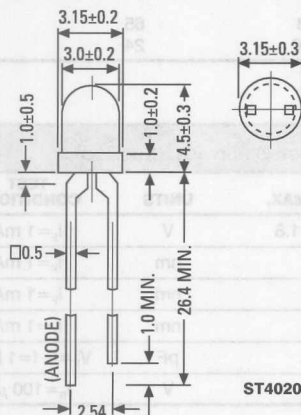


DOUBLE HETEROJUNCTION AlGaAs LOW CURRENT RED LED LAMPS

T-1^{3/4} HLMP-D150A/D155A

T-1 HLMP-K150/K155

PACKAGE DIMENSIONS



DESCRIPTION

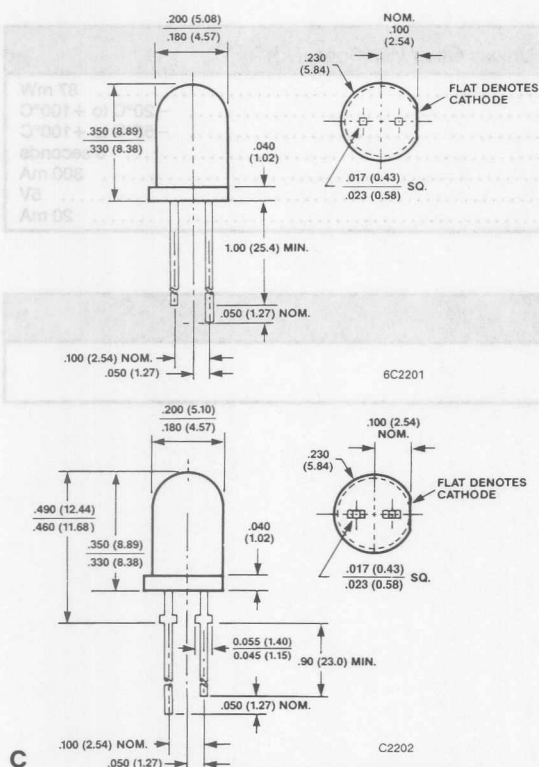
A recently developed double heterojunction (DH) AlGaAs/GaAs material technology is the basis of the light emitting chip utilized in these solid state lamps. Exceptional light output typifies these devices and provides for their use over a broad range of drive currents. At a dominant wavelength of 637 nanometers, the light is perceived as a deep red color. These lamps are ideally suited for use in applications where high light output is required with minimum power input.

FEATURES

- Luminous intensity specified at 1 mA
- High light output at low currents
- Wide viewing angle
- Low power/low forward voltage
- Outstanding material efficiency
- CMOS/MOS compatible
- TTL compatible
- Deep red color

APPLICATIONS

- Low power circuits
- Battery powered equipment
- Telecommunication indicators



C

1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE $\pm .010"$ UNLESS OTHERWISE SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT $.040"$ (1 mm) DOWN THE LEADS

6

HLMP-D150A/D155A HLMP-K150/K155

PHYSICAL CHARACTERISTICS

SIZE	TYPE	LENS EFFECT	I_V (mcd) MIN.	@ 1mA TYP.	VIEWING ANGLE 2 θ 1/2 DEGREES	PKG.
T-1	HLMP-K150	Red Tinted Diffused	1.2	2	60	A
T-1	HLMP-K155	Clear	2	3	45	A
T-1 $\frac{1}{4}$	HLMP-D150A	Red Tinted Diffused	1.2	3	65	B
T-1 $\frac{1}{4}$	HLMP-D155A	Clear	5	10	24	C

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

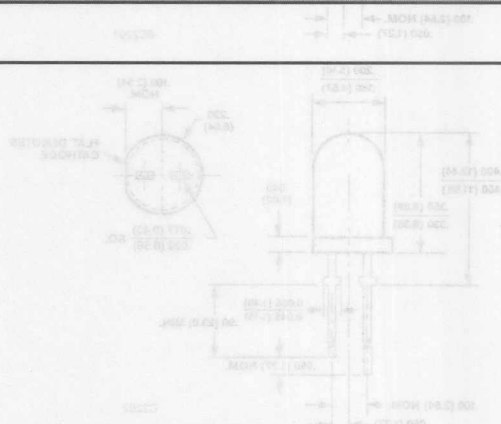
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage	V_F		1.6	1.8	V	$I_F = 1\text{ mA}$
Peak wavelength	λ_p		645		nm	$I_F = 1\text{ mA}$
Dominant wavelength	λ_d		637		nm	$I_F = 1\text{ mA}$
Spectral line half width	$\Delta\lambda_{1/2}$		20		nm	$I_F = 1\text{ mA}$
Capacitance	C		30		pF	$V_F = 0, f = 1\text{ MHz}$
Reverse breakdown voltage	V_R	5.0	15.0		V	$I_R = 100\text{ }\mu\text{A}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	87 mW
Operating temperature	-20°C to $+100^\circ\text{C}$
Storage temperature	-55°C to $+100^\circ\text{C}$
Lead soldering time at 260°C	5 seconds
Peak forward current (see Note 1)	300 mA
Reverse voltage ($I_R = 100\text{ }\mu\text{A}$)	5V
Average forward current (see Note 2)	20 mA

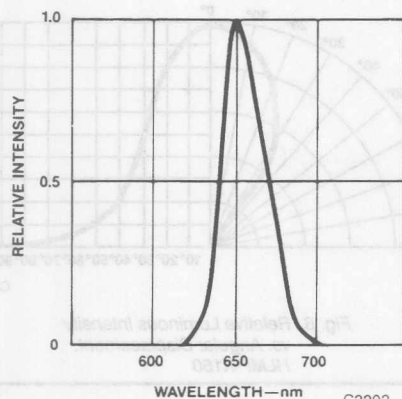
NOTES

1. Maximum I_{peak} at $f = 1\text{ kHz}$, $DF = 6.7\%$
2. Derate linearly as shown in Figure 4.



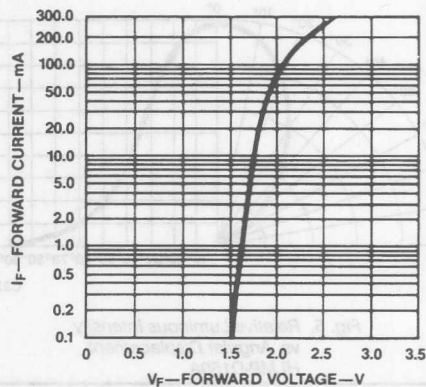
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)



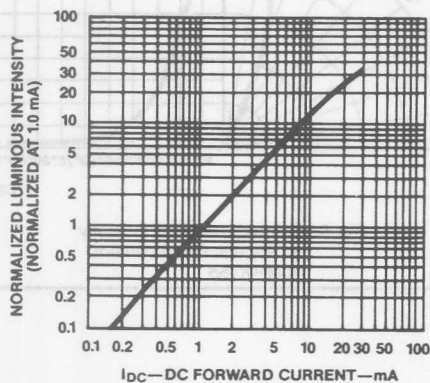
C2203

Fig. 1. Relative Intensity
vs. Wavelength



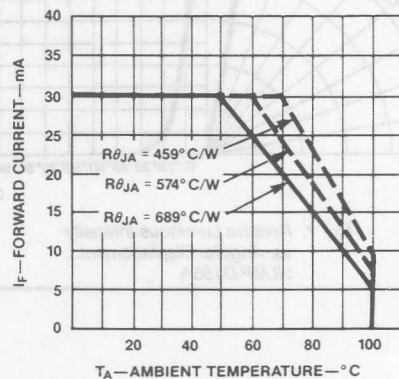
C2214

Fig. 2. Forward Current vs.
Forward Voltage



C2213

Fig. 3. Relative Luminous Intensity
vs. DC Forward Current



C2205

Fig. 4. Maximum Forward DC Current
vs. Ambient Temperature. Derating
Based on T_J MAX = 110°C

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature) (Cont'd)

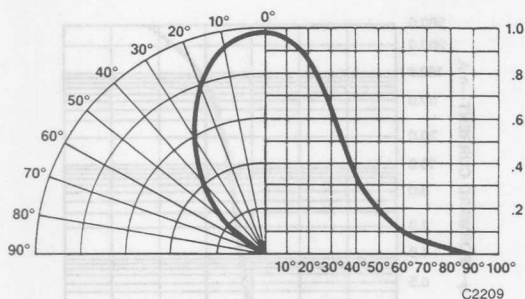


Fig. 5. Relative Luminous Intensity
vs. Angular Displacement.
HLMP-D150A

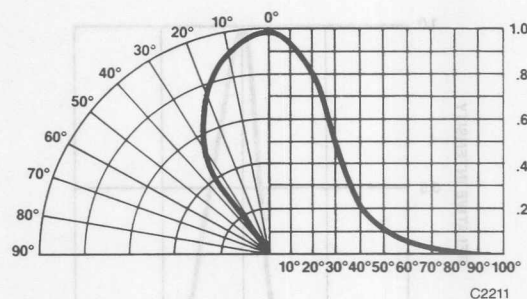


Fig. 6. Relative Luminous Intensity
vs. Angular Displacement.
HLMP-K150

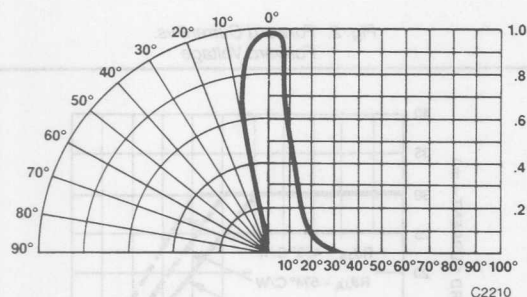


Fig. 7. Relative Luminous Intensity
vs. Angular Displacement.
HLMP-D155A

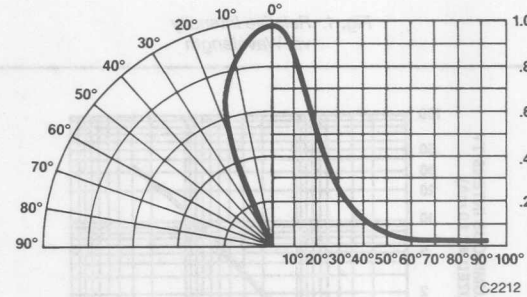
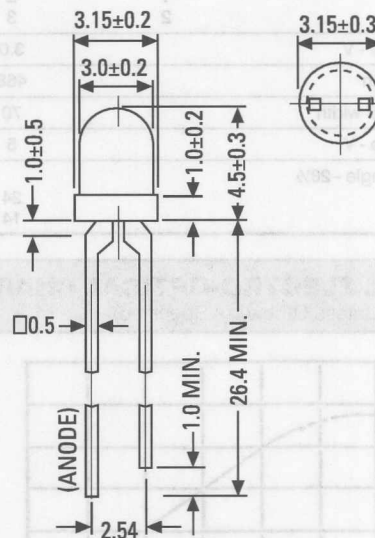
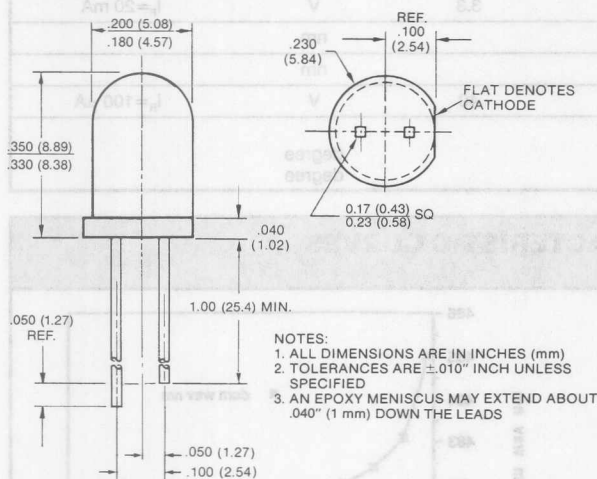


Fig. 8. Relative Luminous Intensity
vs. Angular Displacement.
HLMP-K155

T-1 $\frac{3}{4}$ MV5B54
T-1 MV5B66

PACKAGE DIMENSIONS



C1062L

ST4020

DESCRIPTION

Both the T-1 $\frac{3}{4}$ and T1 package are lightly tinted LEDs. The LEDs is manufactured with the single crystal silicon carbide technology. The color emitted is an 80% saturated blue with a dominant wavelength of 481 nm.

FEATURE

- Silicon carbide technology
- 481 nm 80% saturated blue
- Standard T-1 $\frac{3}{4}$ and T1 package
- CMOS/MOS compatible

APPLICATIONS

- Medical instrumentation
- Front panel status indicator
- Moving message signs

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current	50 mA
Derate linearly from 50°C	-0.7 mA/°C
LED Junction temperature	110°C
Reverse voltage (at $I_R = 100 \mu\text{A}$)	5 V
Storage and operating temperature	-55°C to +100°C
Soldering time at 260°C	5 sec

TYPICAL THERMAL CHARACTERISTICS

Thermal Resistance Junction to free air θ_{JA}	330°C/W
Wavelength temperature coefficient (case temperature)	1.0 Å/°C
Forward voltage temperature coefficient	-1.4 mV/°C

6

MV5B54 MV5B66

ELECTRO-OPTICAL CHARACTERISTICS (T_A = 25°C Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity I _v					
MV5B54	1	2		mcd	I _F =20 mA
MV5B66	2	3		mcd	I _F =20 mA
Forward voltage - V		3.0	3.3	V	I _F =20 mA
Peak wavelength		468		nm	
Spectral line half width		70		nm	
Reverse voltage - V		5	40	V	I _R =100 μA
Total viewing angle - 2θ				degree	
MV5B54		24		degree	
MV5B66		14		degree	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(T_A = 25°C Unless Otherwise Specified)

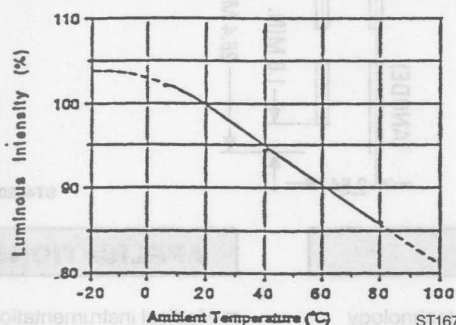


Fig. 1. Between 20-80°C The equation of the curve is $y = 104.3 - 0.233x$
The dotted lines denote extrapolated data

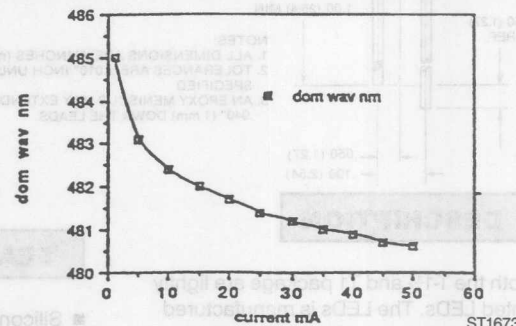


Fig. 2. The peak wavelength stays the same width respect to current

LED Short Duty Cycle Operating Curve
Based on High V_F Limit Device (3.7@50mA DC)

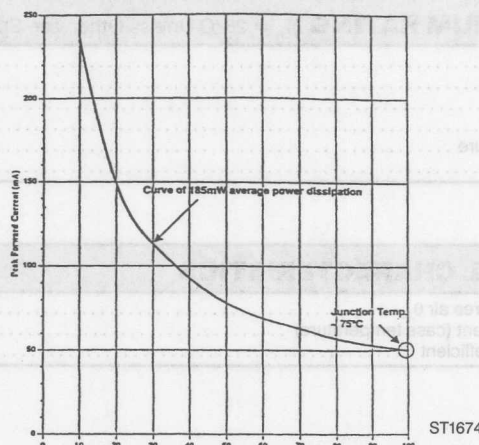
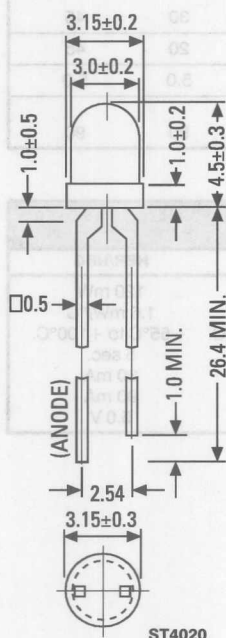


Fig. 3. Duty Cycle (%)

**RED MV50640
YELLOW MV5364X
HIGH EFFICIENCY GREEN MV5464X/HLMP-15X3
HIGH EFFICIENCY RED MV5764X/HLMP-130X**

PACKAGE DIMENSIONS



ST4020

NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These solid state indicators offer a variety of color selection. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. The High Efficiency Green utilizes an improved gallium phosphide light emitting diode. All are encapsulated in epoxy packages with diffused lenses. Their small size, wide viewing angle, and small square leads contribute to their versatility as all-purpose indicators.

FEATURES

- Replacement for the HLMP-1300 and -1500 product series
- 100 mil lead spacing T-1
- High efficiency GaP light
- Versatile mounting on PC board or panel
- Wide viewing angle
- Diffused tinted lens

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT	LUMINOUS INTENSITY at 25°C (mcd)		TEST CONDITIONS
			MIN.	TYP.	
MV50640	Standard Red	Red Diffused	0.5	1.5	$I_F = 20 \text{ mA}$ $I_F = 10 \text{ mA}$
MV53640	Yellow	Yellow Diffused	1.0	2.0	
MV53641			1.5	3.0	
MV53642			2.5	4.5	$I_F = 20 \text{ mA}$
MV54643 (HLMP-1503)	High Efficiency Green	Green Diffused	2.0	5.0	
MV54644 (HLMP-1523)			6.0	10.0	
MV57640 (HLMP-1300)	High Efficiency Red	Red Diffused	1.0	2.0	$I_F = 10 \text{ mA}$
MV57641 (HLMP-1301)			2.0	2.5	
MV57642 (HLMP-1302)			3.0	4.0	

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

PARAMETER		SYMBOL	TEST COND.	UNITS	MV50640* RED	MV5364X YELLOW	MV5464X HI. EFF. GREEN	MV5764X HI. EFF. RED
Forward voltage	typ. max.	V_F	$I_F = 10 \text{ mA}$	V	1.6 2.0	2.1 3.0	2.2* 3.0*	2.0 3.0
Peak wavelength		λ	$I_F = 10 \text{ mA}$	nm	660	585	562	635
Spectral line half width			$I_F = 10 \text{ mA}$	nm	20	35	30	45
Capacitance	typ.	C	$V = 0, f = 1 \text{ MHz}$	pF	23	45	20	45
Reverse voltage	min.	V_{BR}	$I_R = 100 \mu\text{A}$	V	5.0	5.0	5.0	5.0
Viewing angle (total)	typ.	20½	See Fig. 3	degrees	90	90	90	90

* $I_F = 20 \text{ mA}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

	YLW.	STD. RED	HER/HEG
Power dissipation at 25°C ambient	85	120 mW	120 mW
Derate linearly from 50°C	1.6 mW/°C	1.6 mW/°C	1.6 mW/°C
Storage and operating temperatures	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Lead soldering time at 260°C (1/16 inch from body)	5 sec.	5 sec.	5 sec.
Continuous forward current at 25°C	20 mA	30 mA	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	60 mA	1.0 A	90 mA
Reverse voltage	5.0 V	5.0 V	5.0 V

MV50640 MV5364X MV5464X/HLMP-15X3 MV5764X/HLMP-130X

TYPE	SOURCE COLOR	LENS EFFECT	LUMINOUS INTENSITY at 25°C (mcd)	TEST CONDITIONS
MV50640	Standard Red	Red Diffused	0.5	$I_F = 20 \text{ mA}$
MV53640	Yellow	Yellow Diffused	1.0	$I_F = 10 \text{ mA}$
MV53641			1.5	
MV53642			2.5	
MV54640	High Efficiency Green	Green Diffused	2.0	$I_F = 20 \text{ mA}$
(HLMP-1503)			2.0	
MV54641			10.0	
(HLMP-1523)			10.0	
MV57640	High Efficiency Red	Red Diffused	1.0	$I_F = 20 \text{ mA}$
(HLMP-1300)			2.0	
MV57641			2.0	
(HLMP-1301)			2.0	
MV57642			2.0	
(HLMP-1302)			2.0	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

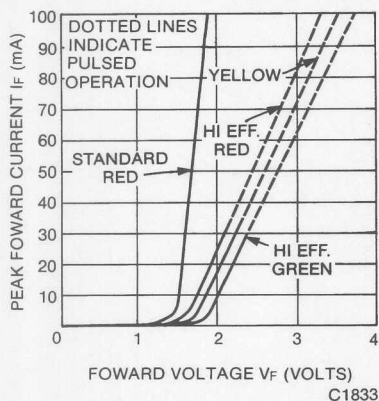


Fig. 1. Forward Current vs. Forward Voltage

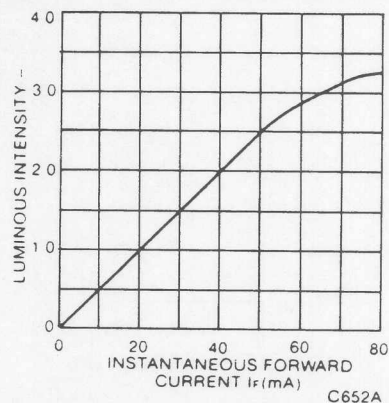


Fig. 2. Luminous Intensity vs. Forward Current

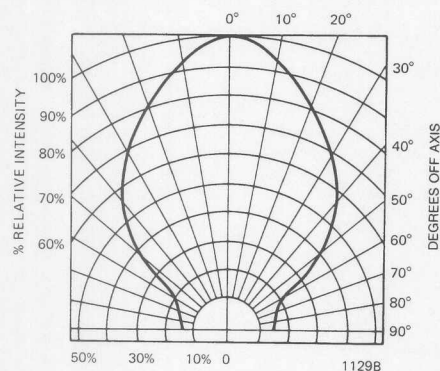


Fig. 3. Spatial Distribution

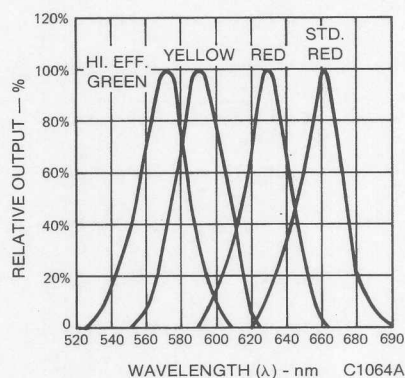


Fig. 4. Spectral Distribution

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

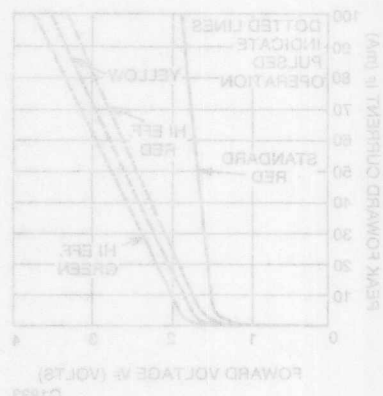


Fig. 1: Forward Current vs. Forward Voltage

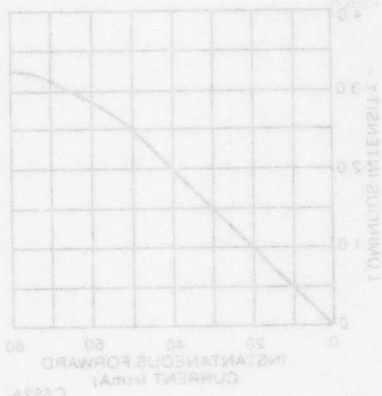


Fig. 2: Luminous Intensity vs. Forward Current

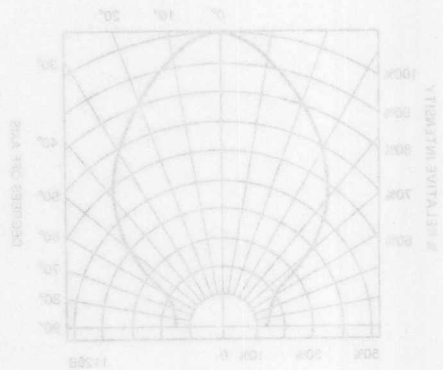


Fig. 3: Spectral Distribution

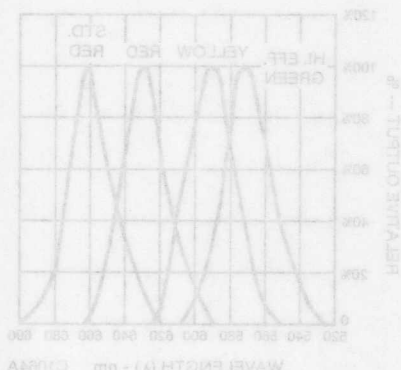
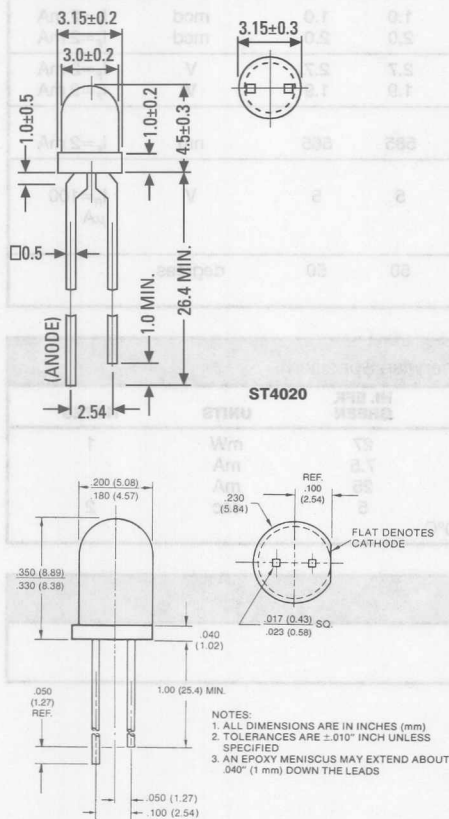


Fig. 4: Spectral Distribution

2 mA

HIGH EFFICIENCY RED HLMP-1700 HLMP-4700
YELLOW HLMP-1719 HLMP-4719
HIGH EFFICIENCY GREEN HLMP-1790 HLMP-4740 (MV2454)

PACKAGE DIMENSIONS



C1062F

DESCRIPTION

The T-1^{3/4} HLMP-4700 Series and T-1 HLMP-1700 Series are direct pin-for-pin replacements for the Hewlett-Packard lamps with the same part numbers. All devices are tinted diffused with a medium-wide viewing angle. The design of the LED chips is optimized for low current applications and is far superior in Luminous Intensity compared to standard LED lamps at very low current.

These low current lamps are primarily intended for direct view.

FEATURES

- Very low power — 4 mW
- 2 mA drive from low power TTL or CMOS
- All three colors
- Power savings in portable equipment
- Sturdier leads for easy assembly
- Both T-1^{3/4} and T-1
- Use MP52 panel mounting grommet with HLMP-4700, HLMP-4719 and MV2454

APPLICATIONS

- Portable battery driven digital or linear electronic equipment like test instruments, robots and toys
- Multiple lamp applications to reduce power drain by 5 to 10 times and decrease power supply size and cost as in phones, PBX and signs

PHYSICAL CHARACTERISTICS

SIZE	TYPE	SOURCE COLOR	LENS EFFECT
T-1	HLMP-1700	High Efficiency Red	Red Diffused
	HLMP-1719	Yellow	Yellow Diffused
	HLMP-1790	High Efficiency Green	Green Diffused
T-1 ^{3/4}	HLMP-4700	High Efficiency Red	Red Diffused
	HLMP-4719	Yellow	Yellow Diffused
	HLMP-4740 (MV2454)	High Efficiency Green	Green Diffused

6

HLMP-17XX HLMP-47XX

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	T-1¾			T-1			UNITS	TEST COND.	
		HI. EFF. RED HLMP-4700	YELLOW HLMP-4719	HI. EFF. GREEN HLMP-4740 (MV2454)	HI. EFF. RED HLMP-1700	YELLOW HLMP-1719	HI. EFF. GREEN HLMP-1790			
Luminous Intensity	min.	I _v	1.2	1.2	1.2	1.0	1.0	1.0	mcd	I _F =2 mA
	typ.		2.0	2.0	3.0	2.0	2.0	2.0	mcd	I _F =2 mA
Forward voltage	max.	V _F	2.2	2.7	2.7	2.2	2.7	2.7	V	I _F =2 mA
	typ.		1.8	1.9	1.9	1.8	1.9	1.9	V	I _F =2 mA
Peak wavelength	typ.	λ _p	635	585	565	635	585	565	nm	I _F =2 mA
Reverse breakdown voltage	min.	V _{BR}	5	5	5	5	5	5	V	I _R =100 μA
Viewing angle (total)	typ.	20½	35	35	35	50	50	50	degrees	

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

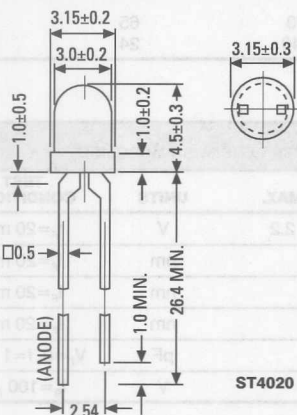
PARAMETER	HI. EFF. RED	YELLOW	HI. EFF. GREEN	UNITS	NOTES
Power dissipation	27	24	27	mW	1
DC forward current	7.5	7.5	7.5	mA	
Peak forward current ($PW \leq 1\text{ ms}$, $DF \leq 30\%$)	25	20	25	mA	
Lead soldering time at 260°C	5	5	5	sec	2
Operating and storage temperatures	-55°C to $+100^\circ\text{C}$				

NOTES

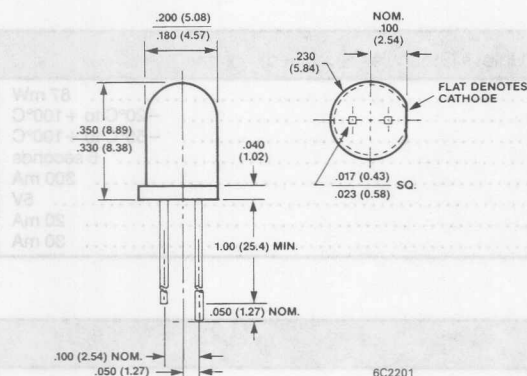
1. Derate linearly from 92°C at $1\text{ mA}/^\circ\text{C}$.
2. At $1/16\text{ inch}$ (1.6 mm) from bottom of lamp.

**T-1 $\frac{3}{4}$ HLMP-D101A/D105A
T-1 HLMP-K101/K105**

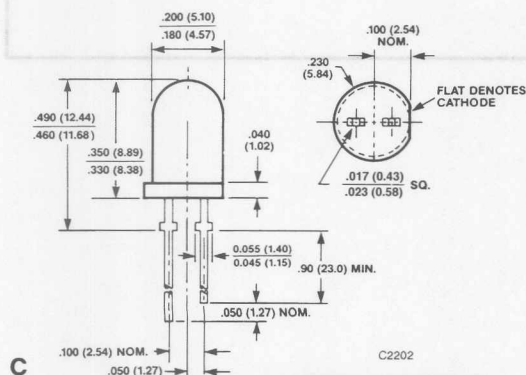
PACKAGE DIMENSIONS



ST4020



6C2201



C2202

1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE ± 0.010 UNLESS OTHERWISE SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1 mm) DOWN THE LEADS

DESCRIPTION

Exceptional light output typifies these devices and provides for their use over a broad range of drive currents. The LED material is based on recently developed double heterojunction (DH) AlGaAs/GaAs technology. The light emitted is perceived as a deep red color, characterized by a dominant wavelength of 637 nanometers.

FEATURES

- Exceptional Brightness
- Wide Viewing Angle
- Outstanding Material Efficiency
- Low Forward Voltage
- CMOS/MOS Compatible
- TTL Compatible
- Deep Red Color

APPLICATIONS

- Bright Ambient Lighting Conditions
- Moving Message Panels
- Portable Equipment
- General Use

PHYSICAL CHARACTERISTICS

SIZE	TYPE	LENS EFFECT	I_V (mcd) MIN	@ 20mA TYPE	VIEWING ANGLE 2Ø1/2 DEGREES	PKG.
T-1	HLMP-K101	Red Tinted Diffused	22	45	60	A
T-1	HLMP-K105	Clear	35	65	45	A
T-1 3/4	HLMP-D101A	Red Tinted Diffused	35	70	65	B
T-1 3/4	HLMP-D105A	Clear	100	240	24	C

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Forward voltage	V_F		1.8	2.2	V	$I_F = 20\text{ mA}$
Peak wavelength	λ_p		645		nm	$I_F = 20\text{ mA}$
Dominant wavelength	λ_d		637		nm	$I_F = 20\text{ mA}$
Spectral line half width	$\Delta\lambda_{1/2}$		20		nm	$I_F = 20\text{ mA}$
Capacitance	C		30		pF	$V_F = 0, f = 1\text{ MHz}$
Reverse breakdown voltage	V_R	5.0	15.0		V	$I_R = 100\text{ }\mu\text{A}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	87 mW
Operating temperature	-20°C to $+100^\circ\text{C}$
Storage temperature	-55°C to $+100^\circ\text{C}$
Lead soldering time at 260°C	5 seconds
Peak forward current (see Note 1)	300 mA
Reverse voltage ($I_R = 100\text{ }\mu\text{A}$)	5V
Average forward current (see Note 2)	20 mA
D.C. current (see Note 3)	30 mA

NOTES

1. Maximum I_{peak} at $f = 1\text{ kHz}$, $DF = 6.7\%$
2. Refer to Figure 6 to establish pulsed operating conditions.
3. Derate linearly as shown in Figure 5.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)

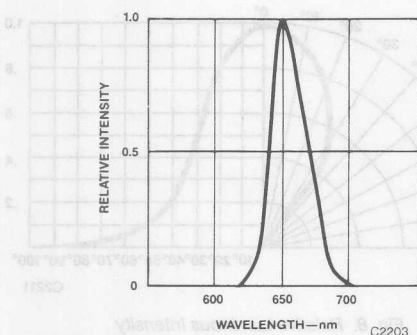


Fig. 1. Relative Intensity vs. Wavelength

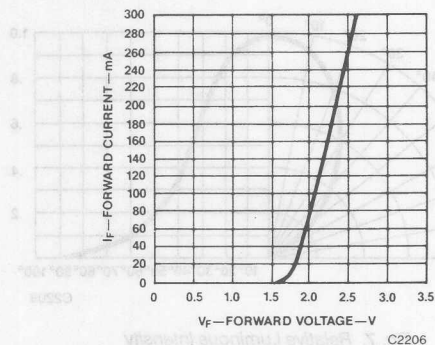


Fig. 2. Forward Current vs. Forward Voltage

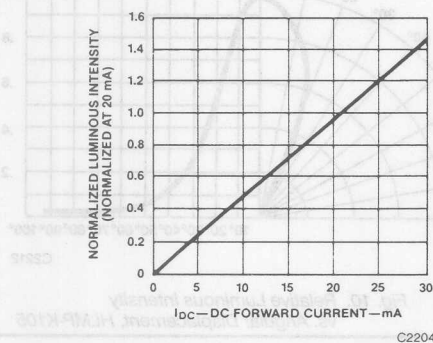


Fig. 3. Relative Luminous Intensity vs. DC Forward Current

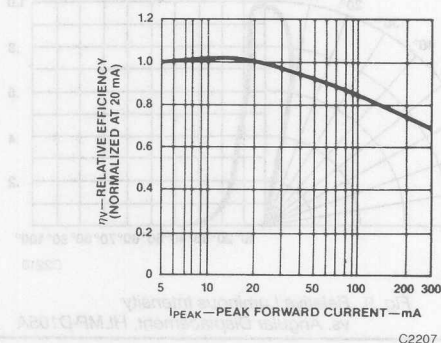


Fig. 4. Relative Efficiency vs. Peak Forward Current

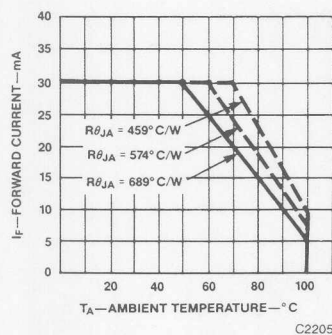


Fig. 5. Maximum Forward DC Current vs. Ambient Temperature, Derating Based on $T_J \text{ MAX} = 110^\circ\text{C}$.

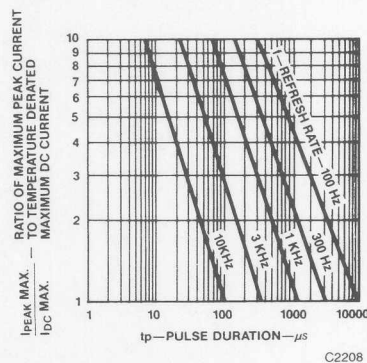


Fig. 6. Maximum Tolerable Peak Current vs. Peak Duration ($I_{\text{PEAK MAX}}$ Determined from Temperature Derated $I_{\text{DC MAX}}$)

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature) (Cont'd)

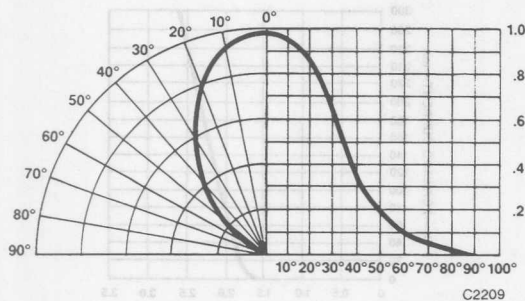


Fig. 7. Relative Luminous Intensity
vs. Angular Displacement, HLMP-D101A

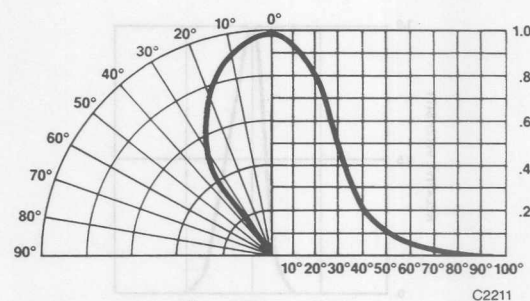


Fig. 8. Relative Luminous Intensity
vs. Angular Displacement, HLMP-K101

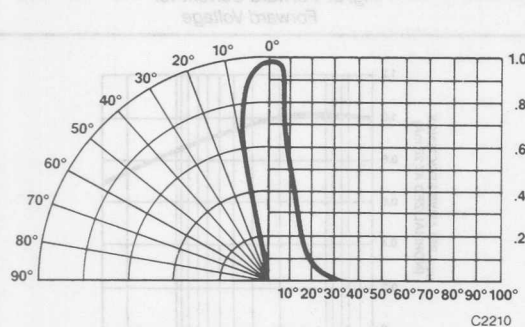


Fig. 9. Relative Luminous Intensity
vs. Angular Displacement, HLMP-D105A

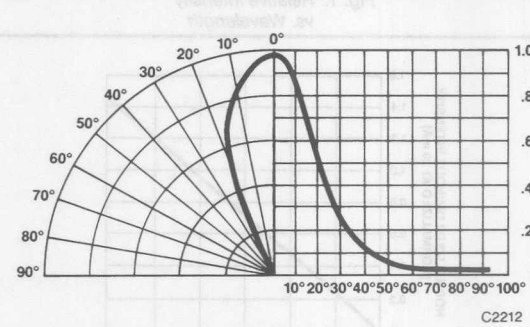
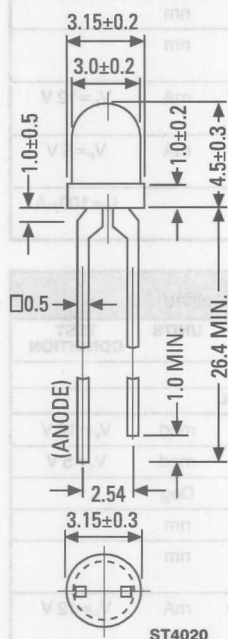


Fig. 10. Relative Luminous Intensity
vs. Angular Displacement, HLMP-K105

RED MR5060 TINTED/MR5660 UNTINTED
HIGH EFFICIENCY RED MR5760/MR5761 TINTED
YELLOW MR5360/MR5361 TINTED
HIGH EFFICIENCY GREEN MR5460/MR5461 TINTED

PACKAGE DIMENSIONS



- NOTES:
1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

This group of T-1 size LED lamps contain integral resistors. Operation at 5 volts (MR5X60 Part Nos.) or 12 volts (MR5X61 Part Nos.) is possible without the use of external current limiting resistors. Color tinted, diffused epoxy packages are used for all the lamps in this group; with the exception of the MR5660, which is no tint - but diffused.

FEATURES

- Integral Current Limiting Resistor
(No external resistor required)
- TTL Compatible
- Operate with 5 Volt & 12 Volt Supplies
- All Colors - Red, HER, Yellow, Green
- Wide Viewing Angle
- Solid-State Reliability

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR
MR5060	Red	Red Diffused
MR5660	Red	Clear Diffused
MR5760	High Efficiency Red	Red Diffused
MR5761	High Efficiency Red	Red Diffused
MR5360	Yellow	Yellow Diffused
MR5361	Yellow	Yellow Diffused
MR5460	High Efficiency Green	Green Diffused
MR5461	High Efficiency Green	Green Diffused

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25°C Unless Otherwise Specified)

RED												HIGH EFFICIENCY RED			UNITS		TEST CONDITION
PARAMETER	SYMBOL	MR5060			MR5660			MR5760			MR5761						
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.				
Luminous Intensity	I _v										1.5	4.0		mcd	V _F =12 V		
Luminous Intensity	I _v	0.8	1.5		0.8	1.5		1.5	4.0					mcd	V _F =5 V		
Total Viewing Angle	2θ1/2		60			60			60			60		Deg			
Peak Wavelength	λ _p		655			655			635			635		nm			
Spectral Line Halfwidth	Δ λ1/2		24			24			40			40		nm			
Forward Current 12V Devices	I _F										13	20		mA	V _F =12 V		
Forward Current 5V Devices	I _F		13	20		13	20		10	15				mA	V _F =5 V		
Reverse Breakdown Voltage	V _R	5.0			5.0			5.0			5.0				I _R =100μA		

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25°C Unless Otherwise Specified)

		YELLOW				HIGH EFFICIENCY GREEN				UNITS		TEST CONDITION
PARAMETER	SYMBOL	MR5360		MR5361		MR5460		MR5461				
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.			MAX.
Luminous Intensity	I _v			1.5	4.0			1.5	4.0	mcd	V _F =12 V	
Luminous Intensity	I _v	1.5	4.0			1.5	4.0			mcd	V _F =5 V	
Total Viewing Angle	2θ1/2		60		60		60		60	Deg		
Peak Wavelength	λp		583		583		565		565	nm		
Spectral Line Halfwidth	Δ λ1/2		36		36		28		28	nm		
Forward Current 12V Devices	I _F			13	20			13	20	mA	V _F =12 V	
Forward Current 5V Devices	I _F	10	15			12	15			mA	V _F =5 V	
Reverse Breakdown Voltage	V _R	5.0		5.0		5.0		5.0			I _R =100μA	

ABSOLUTE MAXIMUM RATINGS (TA = 25°C Unless Otherwise Specified)

	RED/HER/YELLOW 5 VOLT LAMPS	RED/HER/YELLOW 12 VOLT LAMPS	GREEN 5 VOLT LAMPS	GREEN 12 VOLT LAMPS
DC Forward Voltage (T _A = 25°C)	7.5 Volts	15 Volts	7.5 Volts	15 Volts
Reverse Voltage (I _R = 100 μA)	5 Volts	5 Volts	5 Volts	5 Volts
Operating Temperature Range	-40°C to +85°C	-40°C to +85°C	-20°C to +85°C	-20°C to +85°C
Storage Temperature Range	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Lead Soldering Temperature	260°C for 5 seconds			

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

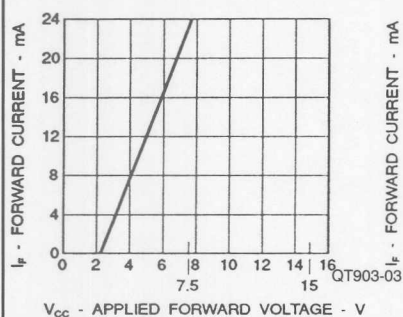


Fig. 1. Forward Current vs. Applied Forward Voltage 5 Volt Devices

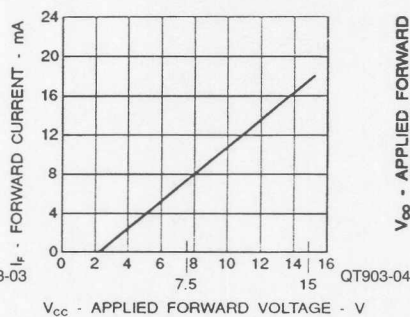


Fig. 2. Forward Current vs. Applied Forward Voltage 12 Volt Devices

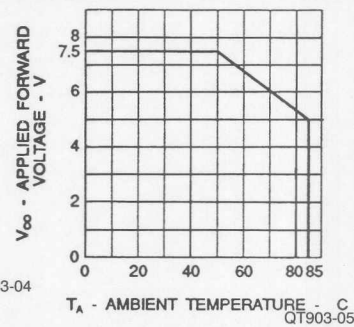


Fig. 3. Maximum Allowed Applied Forward Voltage vs. Ambient Temperature $R\theta_{JA} = 175^\circ\text{C/W}$ 5 Volt Devices

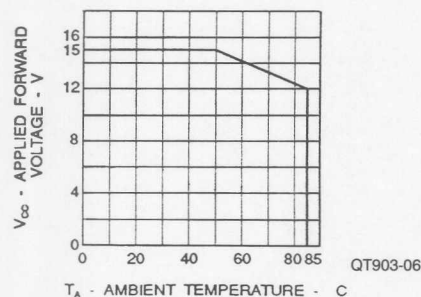


Fig. 4. Maximum Allowed Applied Forward Voltage vs. Ambient Temperature $R\theta_{JA} = 175^\circ\text{C/W}$ 12 Volt Devices

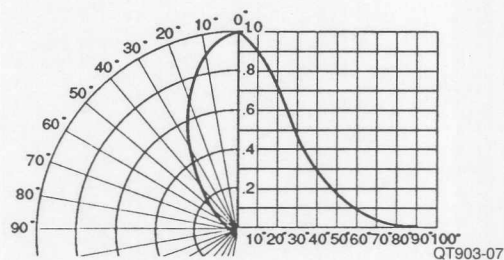


Fig. 5. Relative Luminous Intensity vs. Angular Displacement for T-1 Package

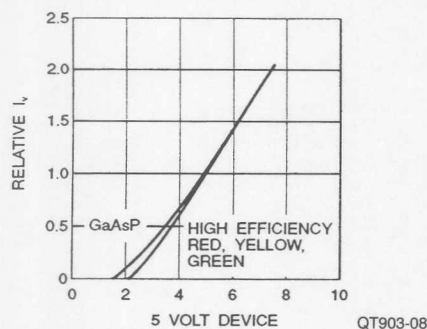


Fig. 6. Relative Luminous Intensity vs. Applied Forward Voltage 5 Volt Devices

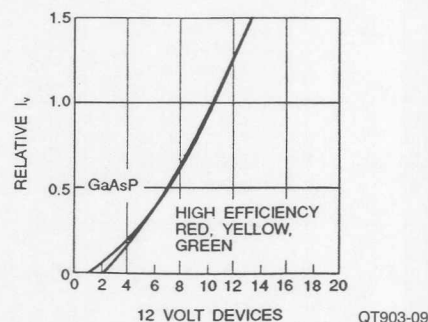
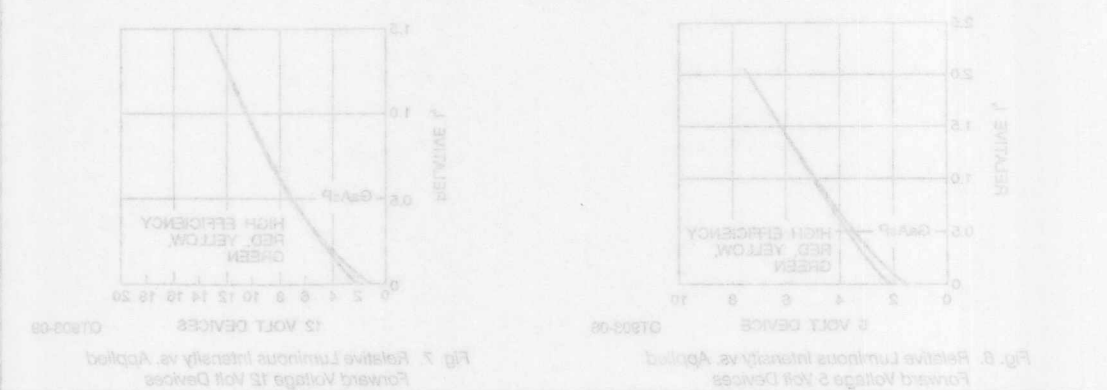
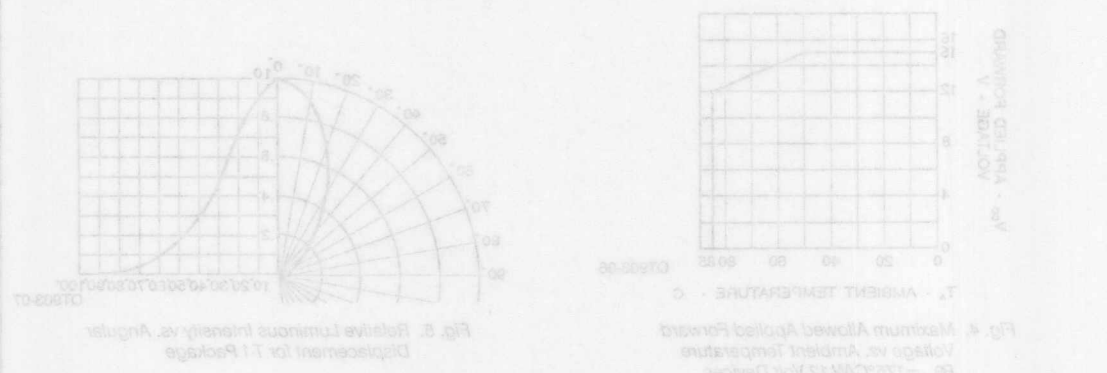
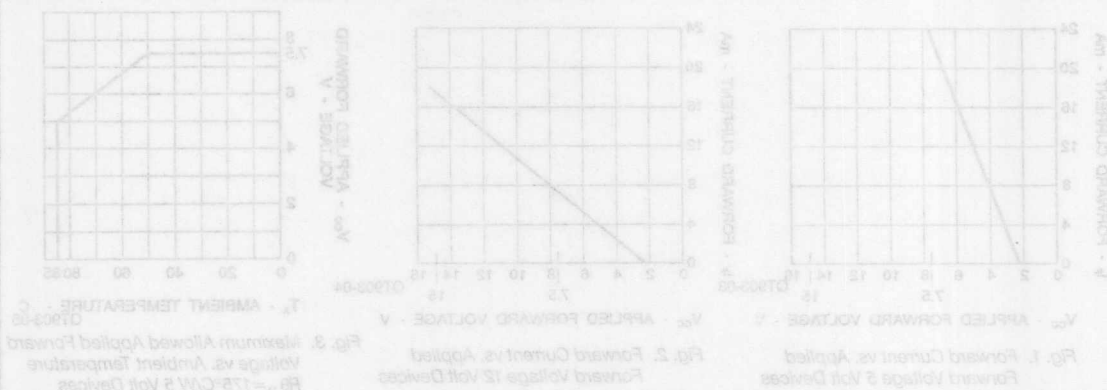


Fig. 7. Relative Luminous Intensity vs. Applied Forward Voltage 12 Volt Devices

MR5060/5660/5760/5761/5360/5361/5460/5461

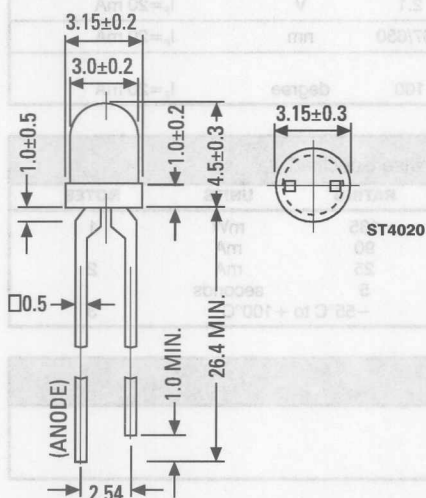
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(TA = 25°C unless otherwise specified)



**HIGH EFFICIENCY GREEN/AlGaAs RED MV6461
HIGH EFFICIENCY RED/AlGaAs RED MV6661**

PACKAGE DIMENSIONS



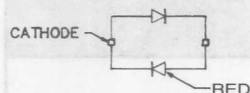
ST4020

DESCRIPTION

The MV6461 is a White Diffused wide viewing angle, dual chip, 4-state lamp utilizing Deep Red AlGaAs and High Efficiency Green AC-driven, the LED lamp appears Orange. The MV6661 is a Red Diffused, wide viewing angle bipolar Red (AC) lamp featuring Red AlGaAs and High Efficiency Red chips.

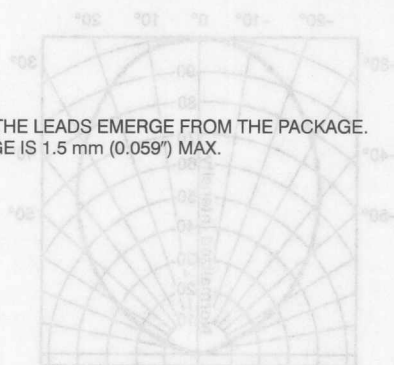
FEATURES

- Excellent uniformity and visual appeal
- Very wide viewing angle for perfect direct view
- Increased reliability
- Radically improved die-off-center characteristics
- Same current for both colors for minimum component count
- Improved solder heat durability
- 4-state; Green, Red, Orange, OFF. (MV6461)
- 100 mil lead spacing



NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.



ELECTRO-OPTICAL CHARACTERISTICS (25°C Unless Otherwise Specified)

PARAMETER		SYMBOL	MV6661	MV6461	UNITS	TEST CONDITIONS
Luminous intensity	min.	I_v	2.5	2.5	mcd	$I_F = 20$ mA
	typ.		10	10	mcd	$I_F = 20$ mA
Forward voltage	max.	V_F	3.0	3.0	V	$I_F = 20$ mA
	typ.		2.1	2.1	V	$I_F = 20$ mA
Dominant wavelength	typ.	λ_d	630/650	567/650	nm	$I_F = 20$ mA
Total viewing angle between half luminous intensity points		$2\theta_{1/2}$	100	100	degree	$I_F = 20$ mA

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

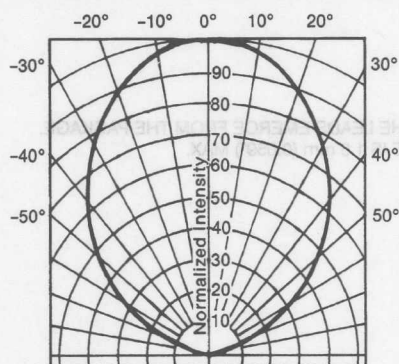
PARAMETERS	RATING	UNITS	NOTES
Power dissipation	135	mW	1
Peak current	90	mA	
Average current	25	mA	2
Lead soldering time	5	seconds	
Storage and operating temperatures	-55°C to +100°C		3

NOTES

1. Derate power linearly from 25°C at 1.8 mW/°C
2. Derate current linearly from 50°C at 0.5 mA/°C
3. To a point minimum 1/16 inch (1.6 mm) from the bottom lamp.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES

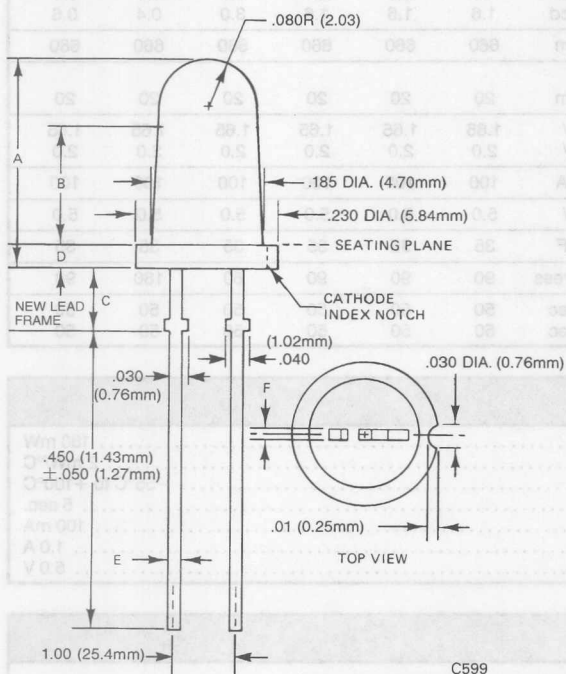
($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)



C1827

Fig. 1. Spatial Distribution

PACKAGE DIMENSIONS



DESCRIPTION

The MV502X Series of solid state indicators is made with gallium arsenide phosphide light emitting diodes. Encapsulation and lens is epoxy. Various lens effects are available for many indicator applications.

FEATURES

- Tapered barrel T-1 $\frac{3}{4}$
- High Intensity Red light source with various lens colors and effects
- T-1 $\frac{3}{4}$ with stand-off
- Versatile mounting on PC board or panel
- Snap in panel mounting clip available (See MP22 for clip detail)

6

PHYSICAL CHARACTERISTICS

TYPE	A	B	C	D	E & F	SOURCE COLOR	LENS COLOR	LENS EFFECT	POP-IN MOUNTING	CIRCUIT BOARD MOUNTING
MV5021A	.340	.190	.100	.040	.020	Red	White Diffused	Soft	X	X
MV5022A	.340	.190	.100	.040	.020	Red	Transparent Red	Point	X	X
MV5023A	.340	.190	.100	.040	.020	Red	Red Diffused	Soft	X	X
MV5024A	.340	.160	.130	.040	.020	Red	Red Diffused	Soft	X	X
MV5025A	.340	.160	.130	.040	.020	Red	Red Diffused	Flooded	X	X
MV5026A	.340	.160	.130	.040	.020	Red	Dark Red Diffused	Flooded	X	X

ELECTRO-OPTICAL CHARACTERISTICS

(25°C Free Air Temperature Unless Otherwise Specified)

PARAMETER	TEST CONDITIONS	UNITS	5021A	5022A	5023A	5024A	5025A	5026A
Luminous Intensity	min. $I_F=20$ mA	mcd	0.5	0.6	0.4	0.9	0.1	0.1
	typ. $I_F=20$ mA	mcd	1.6	1.6	1.6	3.0	0.4	0.6
Peak wavelength	$I_F=20$ mA	nm	660	660	660	660	660	660
Spectral line half width	$I_F=20$ mA	nm	20	20	20	20	20	20
Forward voltage V_F	typ. $I_F=20$ mA	V	1.65	1.65	1.65	1.65	1.65	1.65
	max. $I_F=20$ mA	V	2.0	2.0	2.0	2.0	2.0	2.0
Reverse current I_R	max. $V_R=5.0$ V	μ A	100	100	100	100	100	100
Reverse voltage V_R	min. $I_R=100$ μ A	V	5.0	5.0	5.0	5.0	5.0	5.0
Capacitance	typ. $V=0$	pF	35	35	35	35	35	35
Viewing angle	Between 50% Points	degrees	90	90	90	60	180	90
Rise time and fall time	10%-90% 50 Ω system	nsec	50	50	50	50	50	50
	typ. 90%-10% 50 Ω system	nsec	50	50	50	50	50	50

ABSOLUTE MAXIMUM RATINGS

Power dissipation at 25°C ambient	180 mW
Derate linearly from 25°C	2 mW/°C
Storage and operating temperatures	-55°C to +100°C
Lead soldering time at 260°C (See Note 1)	5 sec.
Continuous forward current at 25°C	100 mA
Peak forward current (1 μ sec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

NOTES

- The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

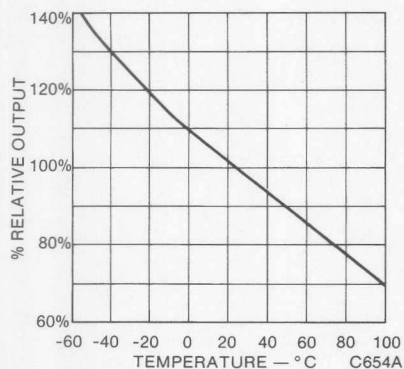


Fig. 1. Output vs. Temperature

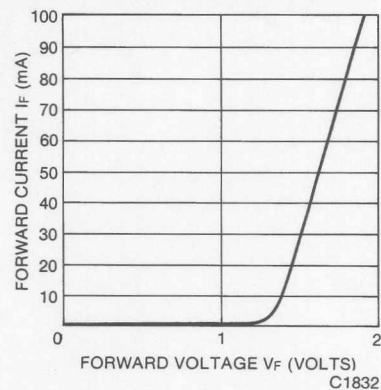


Fig. 2. Forward Current vs. Forward Voltage

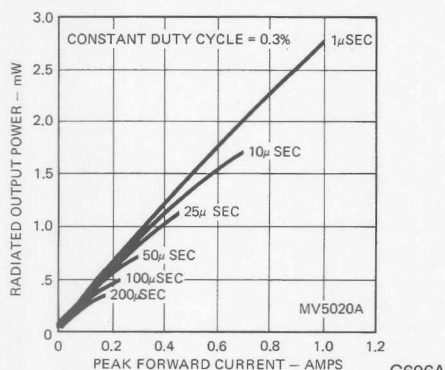


Fig. 3. Radiated Output Power vs. Peak Forward Current

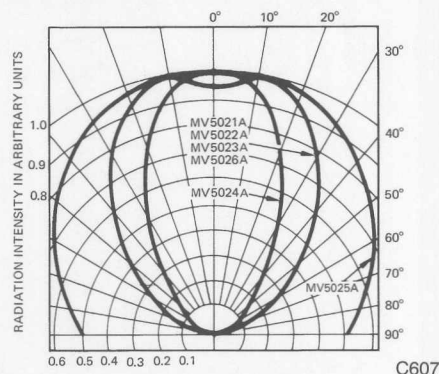


Fig. 4. Spatial Distribution

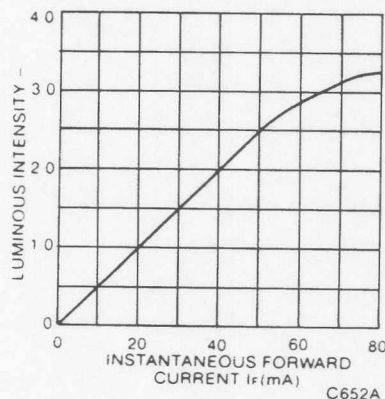


Fig. 5. Luminous Intensity vs. Forward Current

TYPICAL ELECTRICAL CHARACTERISTICS CURVES

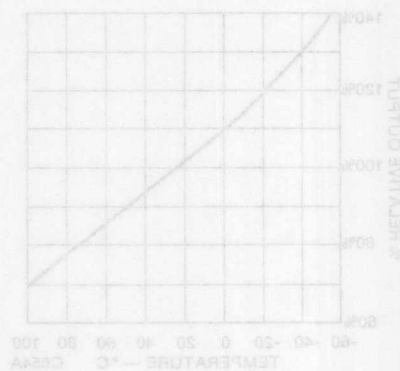


Fig. 1. Output vs. Temperature

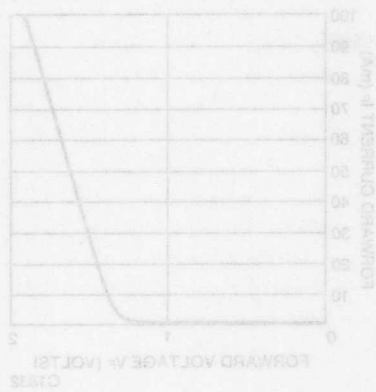


Fig. 2. Forward Current vs. Forward Voltage

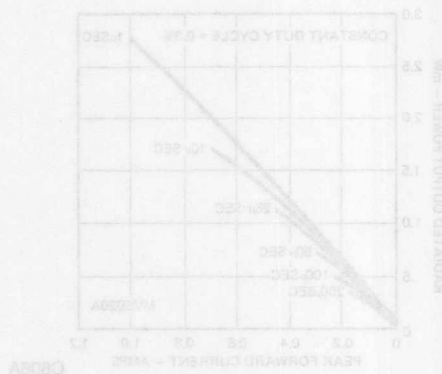


Fig. 3. Radiated Output Power vs. Peak Forward Current

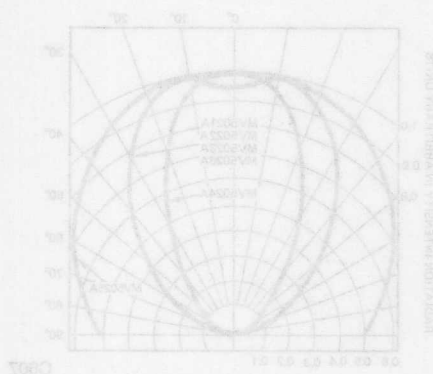


Fig. 4. Spatial Distribution

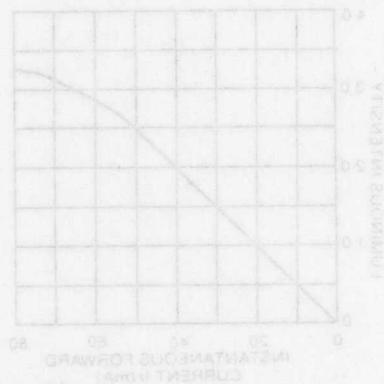
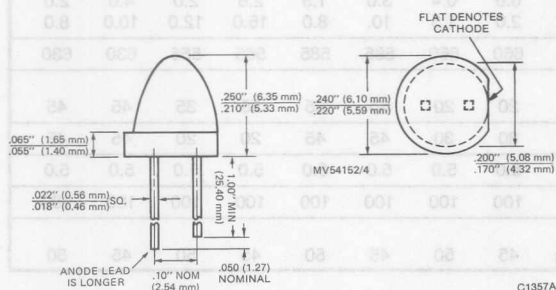


Fig. 5. Luminous Intensity vs. Forward Current

**STANDARD RED MV50152/4
YELLOW MV53152/4**

**HIGH EFFICIENCY GREEN MV54152/4
HIGH EFFICIENCY RED MV57152/4**

PACKAGE DIMENSIONS



DESCRIPTION

These solid state indicators offer a variety of lens effects and color availability in a short barrel T-1 $\frac{3}{4}$ package. The High Efficiency Red, High Efficiency Green and Yellow devices are made with gallium phosphide.

FEATURES

- High intensity light source with two lens effects
- Red, High Efficiency Red, High Efficiency Green and Yellow colors available
- Versatile mounting on PC board or panel
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight
- High efficiency
- MV5X154 diffused, MV5X152 non-diffused
- Short T-1 $\frac{3}{4}$ size

NOTES:

1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE .010 INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1 mm) DOWN THE LEADS

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT
MV50152	Standard Red	Red Clear	Point Source
MV50154	Standard red	Red Lightly Diffused	Soft Point Source
MV53152	Yellow	Amber Clear	Point Source
MV53154	Yellow	Amber Lightly Diffused	Soft Point Source
MV54152	High Efficiency Green	Green Clear	Point Source
MV54154	High Efficiency Green	Green Lightly Diffused	Soft Point Source
MV57152	High Efficiency Red	Orange Clear	Point Source
MV57154	High Efficiency Red	Orange Lightly Diffused	Soft Point Source

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	TEST COND.	UNITS	50152	50154	53152	53154	54152	54154	57152	57154
Forward voltage	typ. max.	V_F $I_F = 10\text{ mA}$ $I_F = 10\text{ mA}$	V	1.6 2.0	1.6 2.0	2.1 3.0	2.1 3.0	2.2 3.0	2.2 3.0	2.0 3.0	2.0 3.0
Luminous Intensity	min. typ.	I_V $I_F = 10\text{ mA}$ $I_F = 10\text{ mA}$	mcd mcd	0.6 2.0	0.4 1.5	3.0 10.	1.5 8.0	2.5 15.0	2.0 12.0	4.0 10.0	2.0 8.0
Peak wavelength	λ_p	$I_F = 10\text{ mA}$	nm	660	660	585	585	565	565	630	630
Spectral line half width		$I_F = 10\text{ mA}$	nm	20	20	35	35	35	35	45	45
Capacitance	typ.	C V=0	pF	30	30	45	45	20	20	45	45
Reverse voltage	min.	V_{BR} $I_R = 100\text{ }\mu\text{A}$	V	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Reverse current	max.	I_R $V_R = 5.0\text{ V}$	μA	100	100	100	100	100	100	100	100
Viewing angle (total) (See Fig. 2)	20 1/2		degrees	45	50	45	50	45	50	45	50

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation (MV5015X)	180 mW
Power dissipation (MV5315X=85 mW)	105 mW
Derate linearly from 25°C (MV5015X)	2.0 mW/ $^\circ\text{C}$
Derate linearly from 25°C	1.14 mW/ $^\circ\text{C}$
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$
Lead soldering time at 260°C (See Note 2)	5 sec.
Continuous forward current (MV5015X)	100 mA
Continuous forward current (MV5315X=20 mA)	35 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) (MV5415X=90 mA) (MV5315X=60 mA)	1.0 A
Reverse voltage	5.0 V

NOTES

1. The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.
2. The leads of the device were immersed in molten solder at 260°C to a point 1/16 inch (1.6 mm) from the body of the device per MIL-Sd-750, with a dwell time of 5 seconds.

MV50152/4 MV53152/4 MV54152/4 MV57152/4

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT
MV50152	Standard Red	Red Clear	Point Source
MV50154	Standard red	Red Lightly Diffused	Soft Point Source
MV53152	Yellow	Amber Clear	Point Source
MV53154	Yellow	Amber Lightly Diffused	Soft Point Source
MV54152	High Efficiency Green	Green Clear	Point Source
MV54154	High Efficiency Green	Green Lightly Diffused	Soft Point Source
MV57152	High Efficiency Red	Orange Clear	Point Source
MV57154	High Efficiency Red	Orange Lightly Diffused	Soft Point Source

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

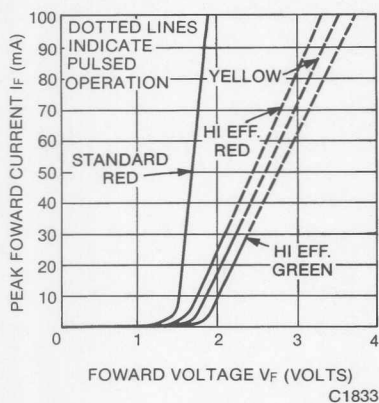


Fig. 1. Forward Current vs. Forward Voltage

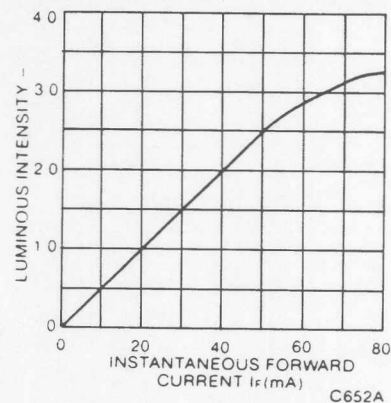


Fig. 2. Luminous Intensity vs. Forward Current

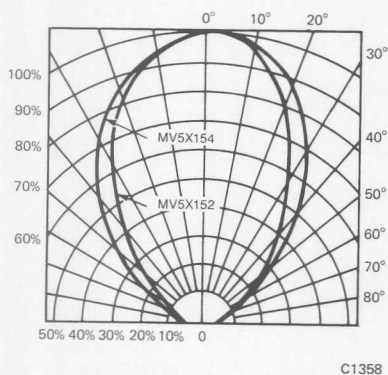


Fig. 3. Spatial Distribution (Note 1)

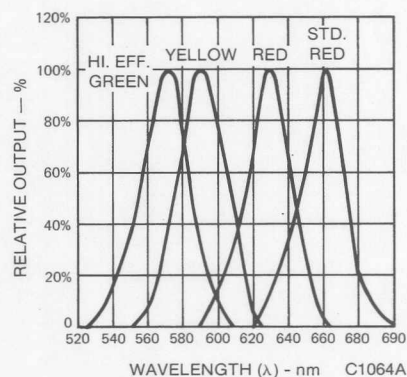


Fig. 4. Spectral Distribution

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS

(All Curves Unless Otherwise Specified)

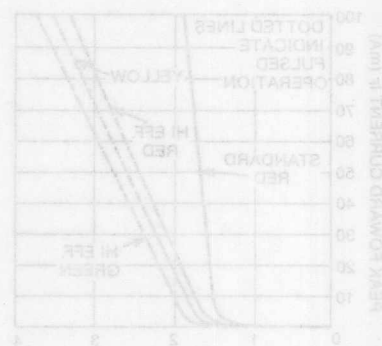


Fig. 1: Forward Current vs. Forward Voltage

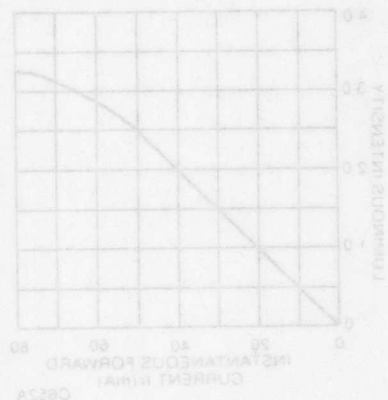


Fig. 2: Luminous Intensity vs. Forward Current

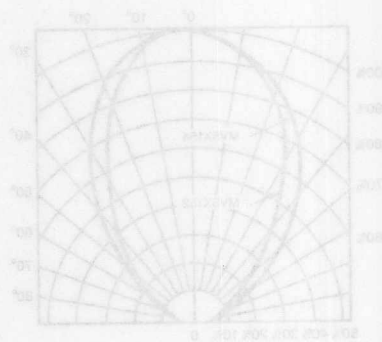


Fig. 3: Beam Spread (Half Angle)

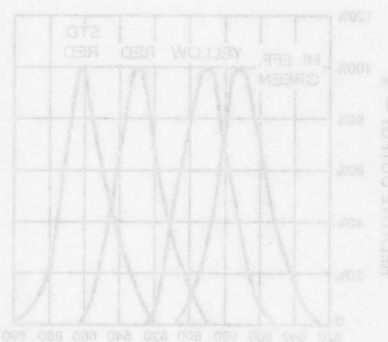
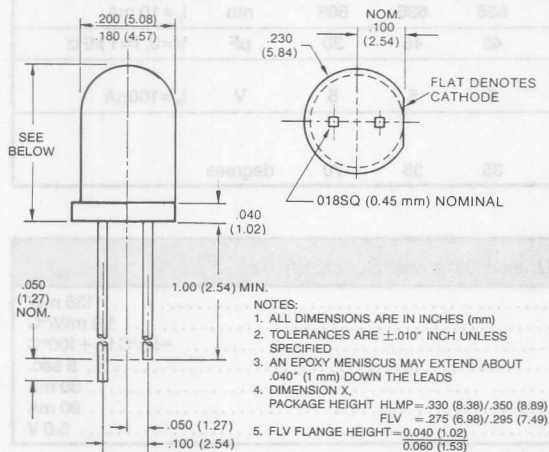


Fig. 4: Spectral Distribution

HIGH EFF. RED HLMP-3300 HIGH EFF. RED HLMP-3315
HIGH EFF. RED HLMP-3301 HIGH EFF. RED HLMP-3316
STANDARD RED FLV110

PACKAGE DIMENSIONS



DESCRIPTION

Direct replacements for popular T-1¾ lamps from Fairchild and Hewlett-Packard. The FLV110 is a Standard Red Lamp with a low profile (.285 inch) lens. HLMP-33XX parts are High Efficiency Red with a standard T-1¾ package.

FLV110, HLMP-3300 and HLMP-3301 are diffused.

HLMP-3315 and HLMP-3316 are non-diffused.

FEATURES

- Replace Fairchild and Hewlett-Packard devices
- Popular, general purpose lamps
- Wide and narrow viewing angle devices for direct view or backlighting
- Solid state reliability
- Sturdy leads for easier assembly

6

FLV110 HLMP-3300 HLMP-3301 HLMP-3315 HLMP-3316

ELECTRO-OPTICAL CHARACTERISTICS (25°C Ambient Temperature)

PARAMETER		SYMBOL	HLMP-3300	HLMP-3301	HLMP-3315	HLMP-3316	FLV* 110	UNITS	TEST CONDITIONS
Luminous Intensity	min.	I_v	2.0	4.0	12	20	0.8*	mcd	$I_F = 10 \text{ mA}$
	typ.		3.5	7.0	18	35	3.0*	mcd	$I_F = 10 \text{ mA}$
Forward voltage	max.	V_F	3.0	3.0	3.0	3.0	2.0	V	$I_F = 10 \text{ mA}$
	typ.		2.2	2.2	2.2	2.2	1.6	V	$I_F = 10 \text{ mA}$
Peak wavelength	typ.	λ_p	635	635	635	635	665	nm	$I_F = 10 \text{ mA}$
Capacitance	typ.	C	45	45	45	45	30	pF	$V = 0, f = 1 \text{ MHz}$
Reverse breakdown voltage	min.	V_{BR}	5	5	5	5	5	V	$I_R = 100 \mu\text{A}$
Total viewing angle between half Luminous Intensity Points	typ.	$2\theta_{1/2}$	65	65	35	35	70	degrees	

*For FLV110 Test $I_F = 20 \text{ mA}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	135 mW
Derate linearly from 25°C	1.8 mW/°C
Storage and operating temperatures	-55°C to +100°C
Lead soldering time @ 260°C (See Note 1)	5 sec.
Continuous forward current	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle) (FLV110 1 amp)	90 mA
Reverse voltage	5.0 V

NOTES

1. From a point minimum 1/16 inch (1.6 mm) from the bottom of the lamp.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

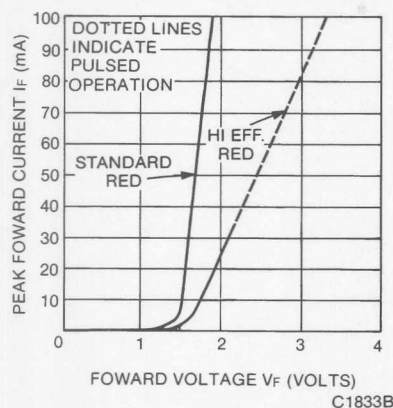


Fig. 1. Forward Current vs.
Forward Voltage

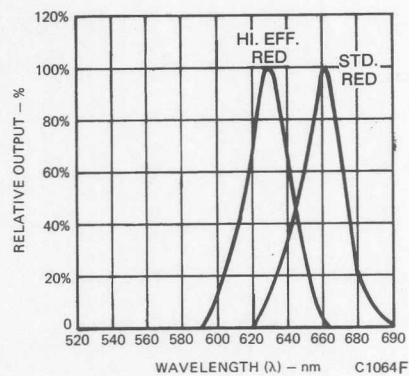


Fig. 2. Spectral Distribution

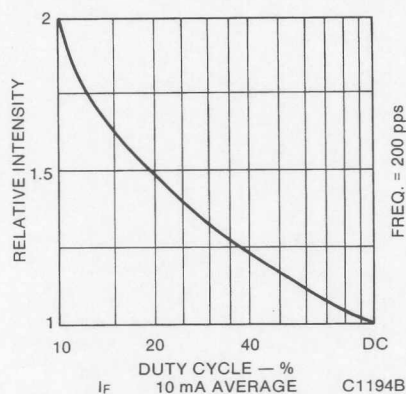


Fig. 3. Luminous Intensity vs.
Duty Cycle

TYPICAL EL RECTRO-OPTICAL CHARACTERISTICS CURVES



Fig. 2. Spectral Distribution
Wavelength (nm) - nm. C1883B

Fig. 1. Forward Current vs.
Forward Voltage
C1883B

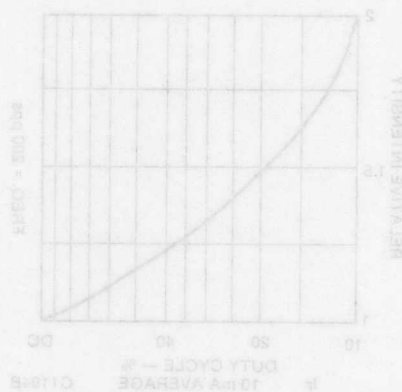
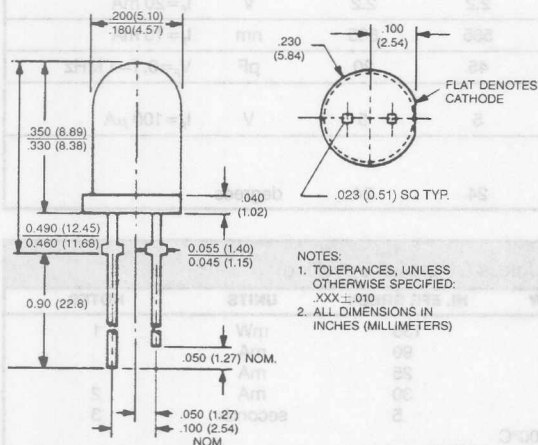


Fig. 3. Luminous Intensity vs.
Duty Cycle
10 mA AVERAGE
C1883B

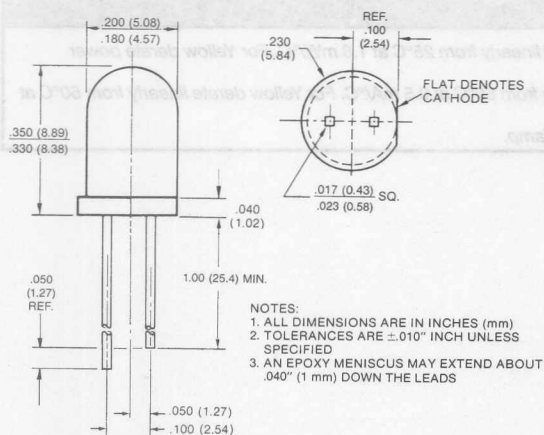
ULTRABRIGHT

HLMP-3X50A SERIES MV3X50A SERIES

PACKAGE DIMENSIONS



HLMP-3X50A



MV3X50A

DESCRIPTION

The Ultrabright HLMP-3X50A Series are direct, pin-for-pin replacements for the Hewlett-Packard devices with the same part numbers.

HLMP-3X50A in High Efficiency Red, Yellow and High Efficiency Green are very narrow viewing angle Clear lamps in a standard T-1 $\frac{3}{4}$ package.

By using more efficient LED chips, these lamps are superior in Luminous Intensity compared to other lamps.

Lamps have Pale Tinted package to aid identification.

FEATURES

- Minimum 80 mcd
- All three colors
- Pale Tint avoids mix problems
- Sturdy leads with or without stand-off on T-1 $\frac{3}{4}$
- Excellent for small area backlighting
- High Efficiency Red
HLMP-3750A
MV3750A
- High Efficiency Green
HLMP-3950A
MV3450A
- Yellow
HLMP-3850A
MV3350A

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER		SYMBOL	MV3750A HLMP-3750A	MV3350A HLMP-3850A	MV3450A HLMP-3950A	UNITS	TEST CONDITIONS
Luminous Intensity	min. typ.	I_v	80 150	80 150	80 150	mcd mcd	$I_F=20\text{ mA}$ $I_F=20\text{ mA}$
Forward voltage	max. typ.	V_F	3.0 2.2	3.0 2.2	3.0 2.2	V V	$I_F=20\text{ mA}$ $I_F=20\text{ mA}$
Peak wavelength	typ.	λ_p	635	585	565	nm	$I_F=10\text{ mA}$
Capacitance	typ.	C	45	45	20	pF	$V_F=0, f=1\text{ MHz}$
Reverse breakdown voltage	min.	BV_R	5	5	5	V	$I_R=100\text{ }\mu\text{A}$
Total viewing angle between half Luminous Intensity points	typ.	$2\theta_{1/2}$	24	24	24	degrees	

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	HI. EFF. RED	YELLOW	HI. EFF. GREEN	UNITS	NOTES
Power dissipation	135	85	135	mW	1
Peak forward current	90	60	90	mA	
Average forward current	25	20	25	mA	
Continuous DC forward current	30	20	30	mA	2
Lead soldering time at 260°C	5	5	5	seconds	3
Operating and storage temperature	$-55\text{ to }+100^\circ\text{C}$				

NOTES

1. For High Efficiency Red and High Efficiency Green, derate power linearly from 25°C at $1.8\text{ mW}/^\circ\text{C}$. For Yellow derate power linearly from 50°C at $1.6\text{ mW}/^\circ\text{C}$.
2. For High Efficiency Red and High Efficiency Green derate linearly from 50°C at $0.5\text{ mA}/^\circ\text{C}$. For Yellow derate linearly from 50°C at $0.2\text{ mA}/^\circ\text{C}$.
3. To a point of minimum $1/16\text{ inch}$ (1.6 mm) from the bottom of the lamp.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

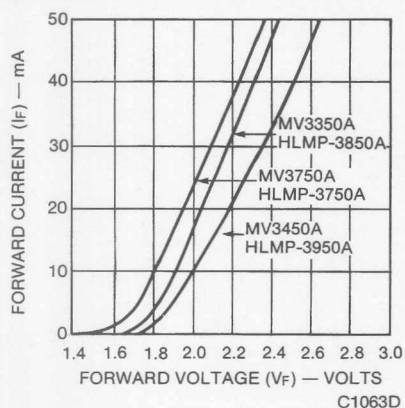


Fig. 1. Forward Voltage/
Forward Current

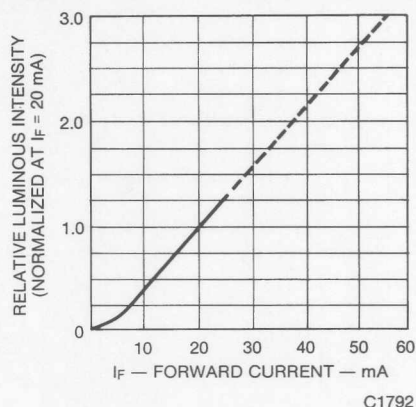


Fig. 2. Relative Luminous Intensity vs.
DC Forward Current

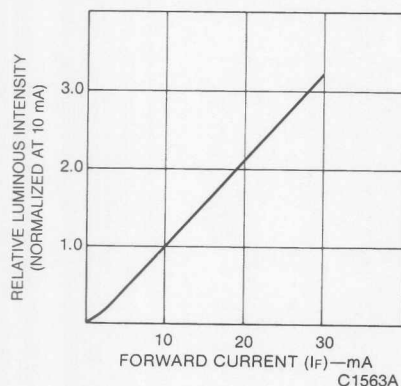


Fig. 3. Spatial Distribution

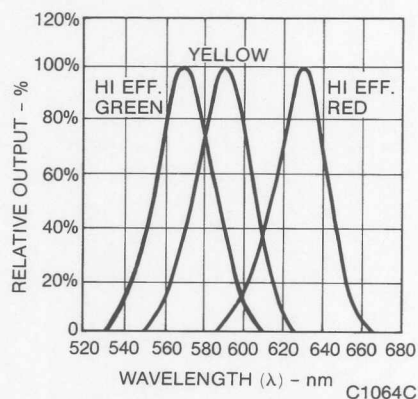


Fig. 4. Spectral Distribution

CHARACTERISTICS

Fig. 1 Forward Voltage vs. Forward Current

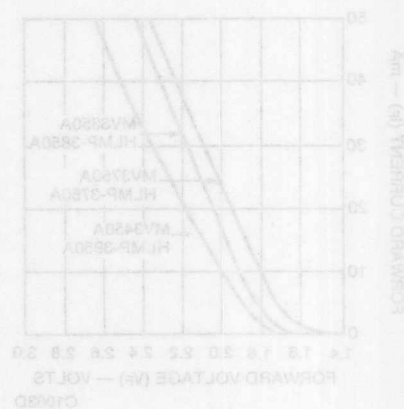


Fig. 1 Forward Voltage vs. Forward Current

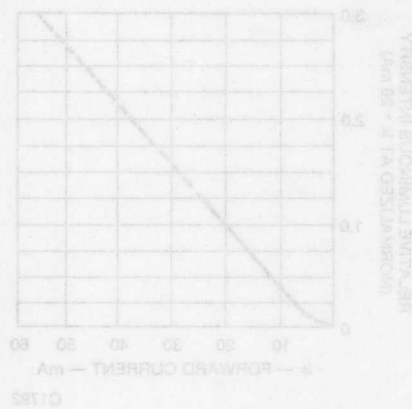


Fig. 2 Relative Luminous Intensity vs. DC Forward Current

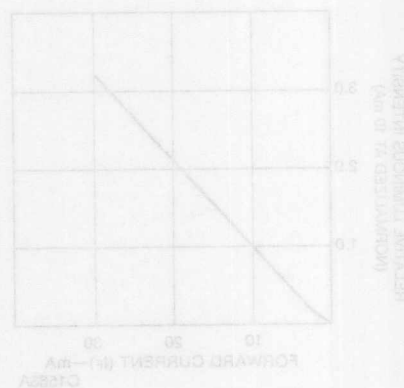


Fig. 3 Spatial Distribution

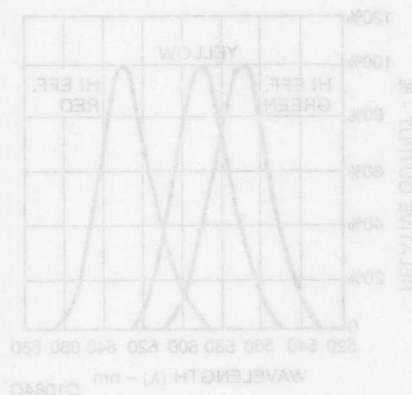
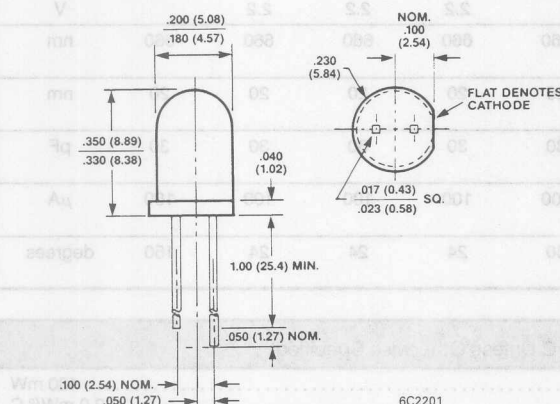


Fig. 4 Spectral Distribution

**MV5052
MV5053/6053**

**MV5054A-1/2/3
MV5055**

PACKAGE DIMENSIONS



DESCRIPTION

The MV505X Series of industry standard solid state indicators is made with gallium arsenide phosphide light emitting diodes encapsulated in epoxy lenses. Various lens effects give different design possibilities.

FEATURES

- Standard Red light source with various lens colors and effects
- Versatile mounting on PC board or panel
- Snap in mounting grommet MP52
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

Wm C .100 (2.54) NOM.
C Wm C .050 (1.27)
C to +100°C
-55°C to +100°C
8 sec
Am OUT
A 0.1
V 0.5

PHYSICAL CHARACTERISTICS

CATHODE LONG	SOURCE COLOR	LENS TYPE	LENS EFFECT	APPLICATION
MV5052	Standard Red	Red Tint	Point Source	Backlighting
MV5053*	Standard Red	Red Diffused	Wide Beam	Direct View
MV5054A-1	Standard Red	Red Diffused	Narrow Beam	Direct View
MV5054A-2	Standard Red	Red Diffused	Narrow Beam	Direct View
MV5054A-3	Standard Red	Red Diffused	Narrow Beam	Direct View
MV5055	Standard Red	Red Diffused	Very Wide Beam	Direct View

*MV6053 – Anode Long also available.

ELECTRO OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	TEST COND.	5052	6053 5053	5054A-1	5054A-2	5054A-3	5055	UNIT
Luminous Intensity I_V min.	$I_F=20\text{ mA}$ $I_F=10\text{ mA}$	0.7	0.5	1.0	2.0	3.0	0.1	mcd mcd
Forward voltage V_F mcd	$I_F=20\text{ mA}$ $I_F=10\text{ mA}$	2.2	2.2	2.2	2.2	2.2	2.2	V V
Peak wavelengths λ_p typical	$I_F=20\text{ mA}$	660	660	660	660	660	660	nm
Spectral line half width typical	$I_F=20\text{ mA}$	20	20	20	20	20	20	nm
Capacitance typical	$V=0$ $f=1\text{ MHz}$	30	30	30	30	30	30	pF
Reverse current I_R max.	$V_R=5.0\text{ V}$	100	100	100	100	100	100	μA
Viewing angle typical, See Figures		72	80	24	24	24	150	degrees

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation	180 mW
Derate linearly from 25°	$2.0\text{ mW}/^\circ\text{C}$
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$
Lead soldering time at 260°C (See Note 2)	5 sec.
Continuous forward current	100 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	1.0 A
Reverse voltage	5.0 V

NOTES

1. The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.
2. The leads of the device were immersed in molten solder at 260°C to a point $1/16$ (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.

MV5052 MV5053/6053 MV5054A-1/2/3 MV5055

APPLICATION	LENS EFFECT	LENS TYPE	SOURCE COLOR	CATHODE COLOR
Backlighting	Point Source	Red Tint	Standard Red	MV5052
Direct View	Wide Beam	Red Diffused	Standard Red	MV5053*
Direct View	Narrow Beam	Red Diffused	Standard Red	MV5054A-1
Direct View	Narrow Beam	Red Diffused	Standard Red	MV5054A-2
Direct View	Narrow Beam	Red Diffused	Standard Red	MV5054A-3
Direct View	Very Wide Beam	Red Diffused	Standard Red	MV5055

*MV5053 - Anode lead also available.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

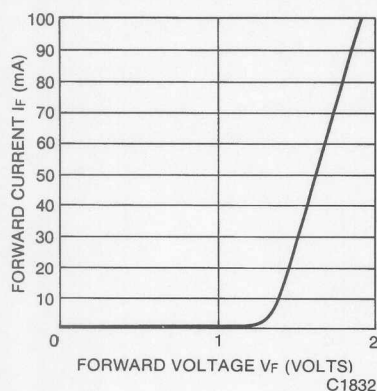


Fig. 1. Forward Current vs. Forward Voltage

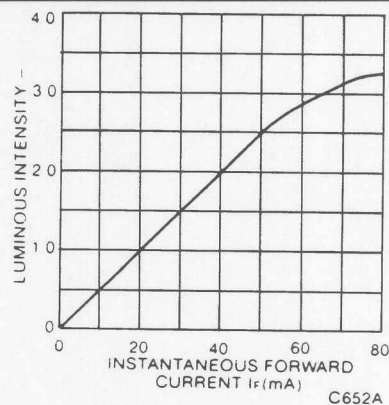


Fig. 2. Luminous Intensity vs. Forward Current

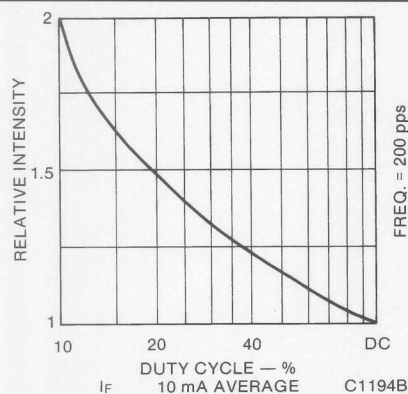


Fig. 3. Luminous Intensity vs. Duty Cycle

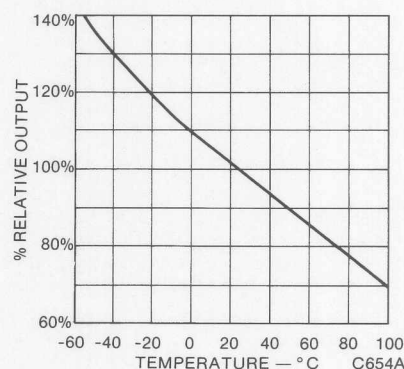


Fig. 4. Output vs. Temperature

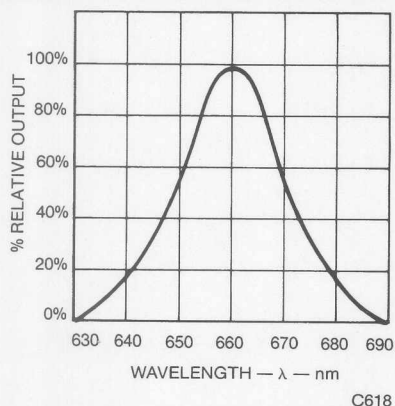


Fig. 5. Spectral Distribution

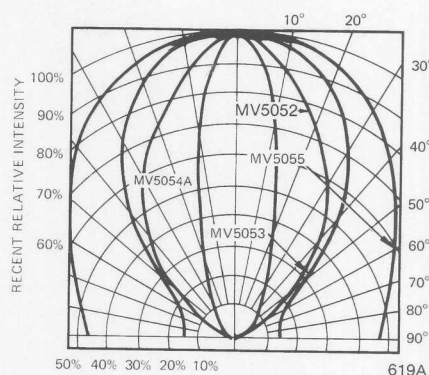


Fig. 6. Spatial Distribution (Note 1)

Typical Electro-Optical Characteristics

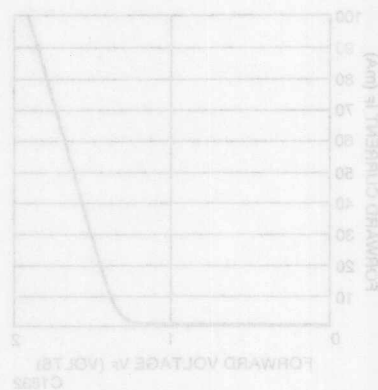


Fig. 1: Forward Current vs. Forward Voltage

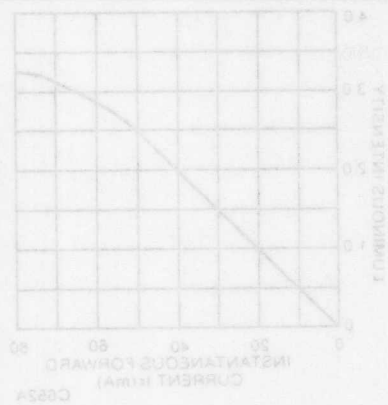


Fig. 2: Luminous Intensity vs. Forward Current

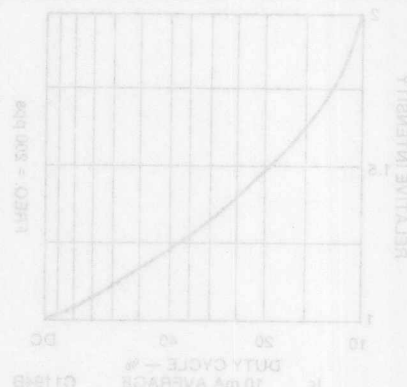


Fig. 3: Luminous Intensity vs. Duty Cycle

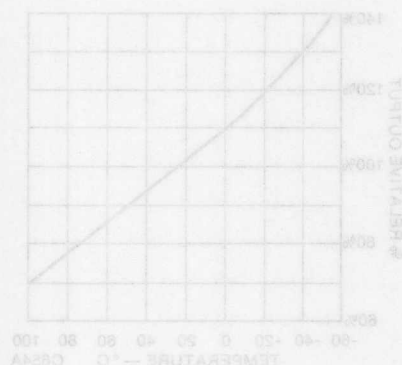


Fig. 4: Output vs. Temperature

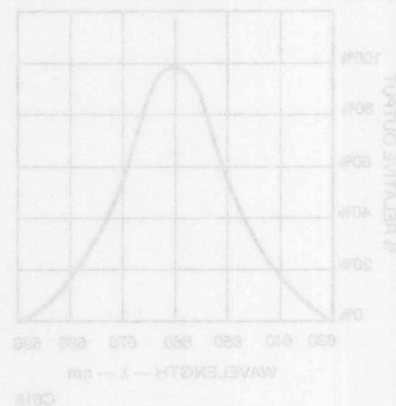


Fig. 5: Spectral Distribution

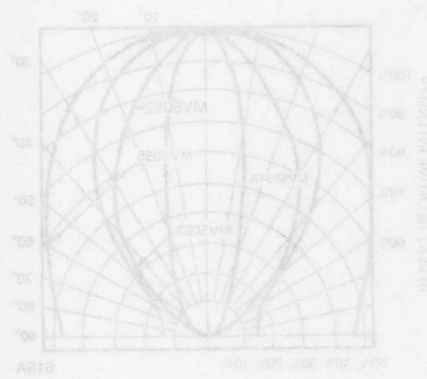
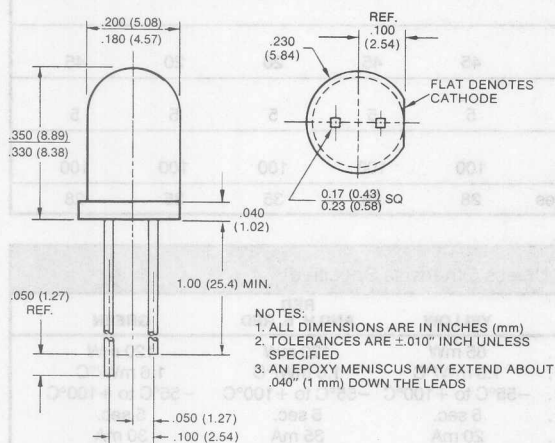


Fig. 6: Spatial Distribution (View 1)

ORANGE MV5152 MV6152
YELLOW MV5352 MV6352
HIGH EFFICIENCY GREEN MV5452 MV64520 MV64521
HIGH EFFICIENCY RED MV5752 MV6752

PACKAGE DIMENSIONS

MV5X52—LEAD CUT CATHODE LONG
MV6X52X—LEAD CUT ANODE LONG



DESCRIPTION

These Clear Tinted solid state indicators offer high brightness and color availability. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. The High Efficiency Green units are made with gallium phosphide on gallium phosphide. All devices are available with cathode long as MV5X5X, or with anode long as MV6X5X.

FEATURES

- High on-axis light output
- High efficiency GaP light sources
- Versatile mounting on PC board or panel
- Snap in grommet MP52 available as separate order item
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

6

PHYSICAL CHARACTERISTICS

CATHODE LONG	ANODE LONG	SOURCE COLOR	LENS TYPE	LENS EFFECT	APPLICATION
MV5152	MV6152	High Efficiency Red	Amber Clear	Point Source	Backlighting
MV5352	MV6352	Yellow	Yellow Clear	Point Source	Backlighting
MV5452	MV64520	High Efficiency Green	Green Clear	Point Source	Backlighting
—	MV64521	High Efficiency Green	Green Clear	Point Source	Backlighting
MV5752	MV6752	High Efficiency Red	Red Clear	Point Source	Backlighting

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	MV6152 MV5152	MV6352 MV5352	MV64520 MV5452	MV64521	MV6752 MV5752
Forward voltage (V _F)							
typ.	I _F =20 mA	V	2.0	2.1	2.2	2.2	2.0
max.	I _F =20 mA	V	3.0	3.0	3.0	3.0	3.0
Luminous Intensity							
min.	I _F =20 mA	mcd	17.0	10.0	12.0	30.0	17.0
typ.	I _F =20 mA	mcd	100.0	90.0	25.0	100.0	100.0
Peak wavelength	I _F =20 mA	nm	635	585	562	562	635
Spectral line half width	I _F =20 mA	nm	45	35	30	30	45
Capacitance							
typ.	V=0, f=1 MHz	pF	45	45	20	20	45
Reverse voltage (V _R)							
min.	I _R =100 μA	V	5	5	5	5	5
Reverse current (I _R)							
max.	V _R =5.0 V	μ A	100	100	100	100	100
Viewing angle (total)	See Fig. 4	degrees	28	28	35	35	28

ABSOLUTE MAXIMUM RATINGS (T_A=25°C Unless Otherwise Specified)

	YELLOW	RED AND H. E. RED	GREEN
Power dissipation	85 mW	120 mW	120 mW
Derate linearly from 25°C (MVX452/4A from 50°C)	1.6 mW/°C	1.6 mW/°C	1.6 mW/°C
Storage and operating temperatures	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Lead soldering time at 260° C (See Note 2)	5 sec.	5 sec.	5 sec.
Continuous forward current	20 mA	35 mA	30 mA
Peak forward current (1 μsec pulse, 0.3% duty cycle)	60 mA	1.0 A	90 mA
Reverse voltage	5.0 V	5.0 V	5.0 V

NOTES

1. The axis of spatial distribution are typically within a 10° cone within reference to the central axis of the device.
2. The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.

APPLICATION	LENS EFFECT	LENS TYPE	SOURCE COLOR	WAVELENGTH	CATHODE LONG
Backlighting	Point Source	Amber Clear	High Efficiency Red	MV6152	MV5152
Backlighting	Point Source	Yellow Clear	Yellow	MV6352	MV5352
Backlighting	Point Source	Green Clear	High Efficiency Green	MV64520	MV5452
Backlighting	Point Source	Green Clear	High Efficiency Green	MV64521	MV5452
Backlighting	Point Source	Red Clear	High Efficiency Red	MV6752	MV5752

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

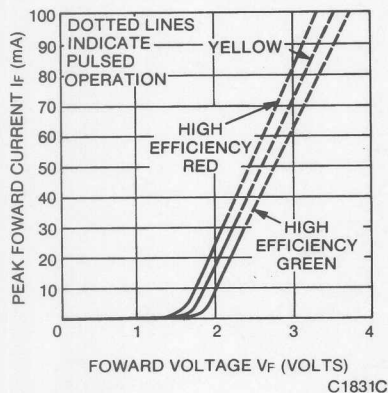


Fig. 1. Forward Current vs. Forward Voltage

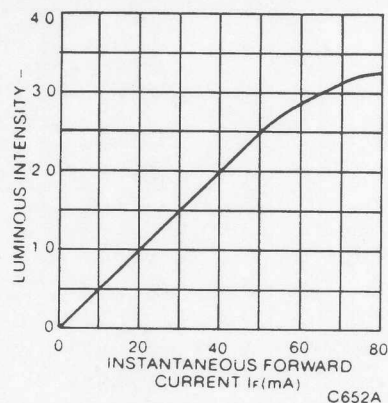


Fig. 2. Luminous Intensity vs. Forward Current

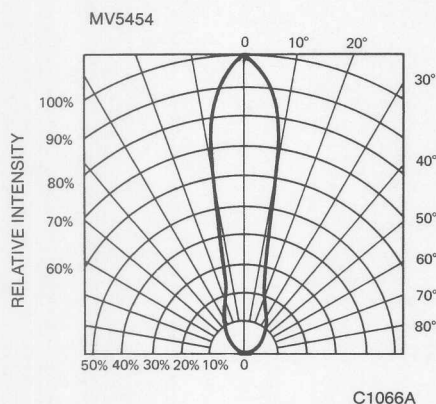


Fig. 3. Spatial Distribution (Note 1)

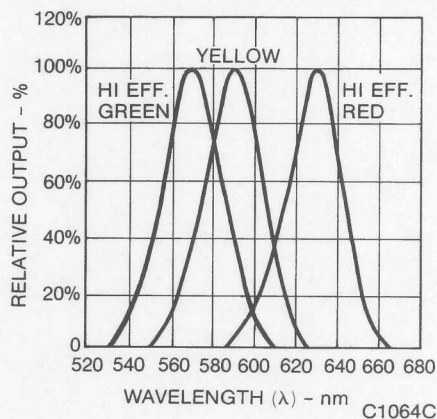
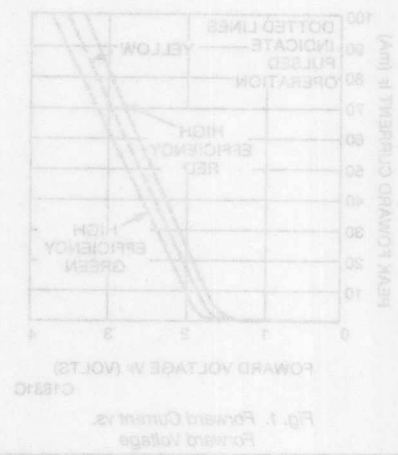
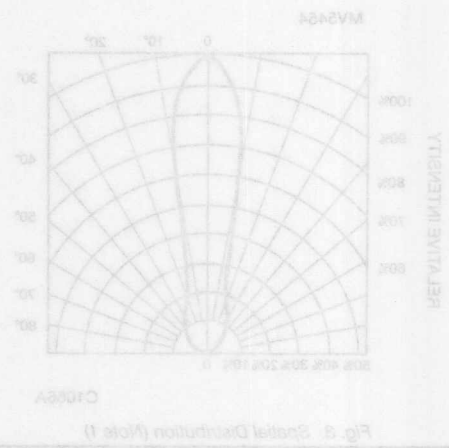
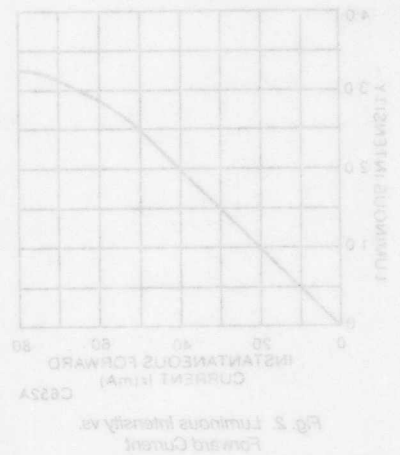
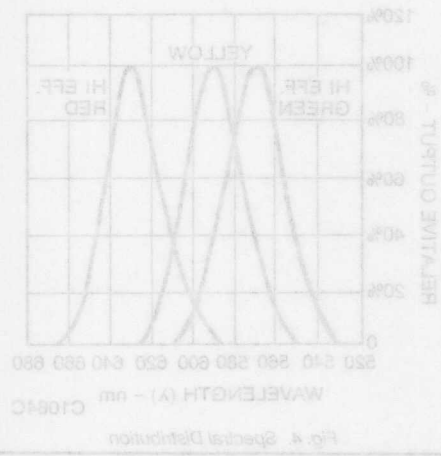


Fig. 4. Spectral Distribution

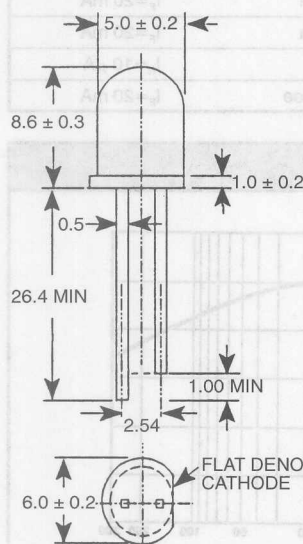
0.1

WAVELENGTH (nm)



**SUPER RED MV8102 CLEAR
SUPER RED MV8103 CLEAR
SUPER RED MV8104 CLEAR**

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
3. PROTRUDED RESIN UNDER FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These T-1 $\frac{3}{4}$ super bright LEDs have a narrow 20° viewing angle for concentrated light output. The MV8101/2/3/4 are made with GaAlAs LEDs on a GaAlAs substrate. They are all encapsulated in an epoxy package and have water clear lenses.

FEATURES

- Outstanding material efficiency
- Popular T-1 $\frac{3}{4}$ package
- Low drive current
- Solid state reliability
- Super high brightness suitable for outdoors applications
- Standard 1 mil. lead spacing

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_f)	40 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time (at $\frac{1}{16}$ inch from bottom of lamp)	5 seconds @ 260°C
Peak forward current (at $f=1.0$ KHz, Duty factor=1/10)	200 mA
Power dissipation (P_d)	110 mW
Recommended operating current (I_f , Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity					
MV8102	250	370		mcd	$I_F = 20\text{ mA}$
MV8103	630	940		mcd	$I_F = 20\text{ mA}$
MV8104	1000	1500		mcd	$I_F = 20\text{ mA}$
Forward voltage	1.5	1.7	2.4	V	$I_F = 20\text{ mA}$
Peak wavelength		660		nm	$I_F = 20\text{ mA}$
Spectral line half width		40		nm	$I_F = 20\text{ mA}$
Reverse breakdown voltage		5		V	$I_R = 10\text{ }\mu\text{A}$
Viewing angle		20		degree	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

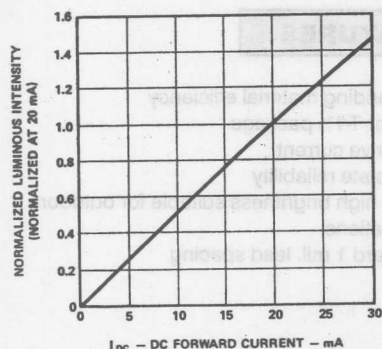


Fig. 1. Relative Luminous Intensity vs. DC Forward Current

ST1002

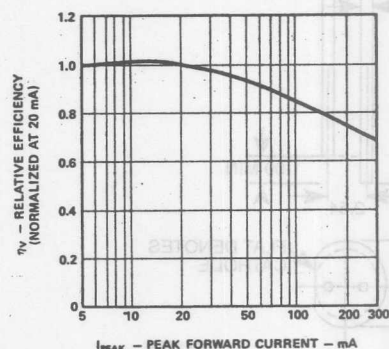


Fig. 2. Relative Efficiency vs. Peak Forward Current

ST1761

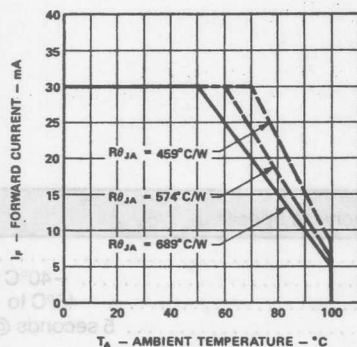


Fig. 3. Maximum Forward DC Current vs. Ambient Temperature Derating Based On $T_{JMAX} = 110^\circ$

ST1762

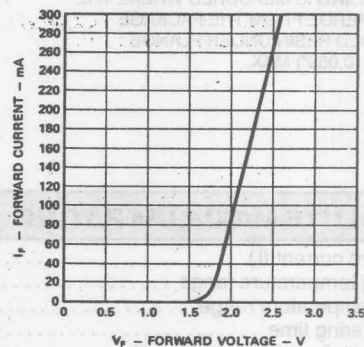


Fig. 4. Forward Current vs. Forward Voltage

ST1763

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

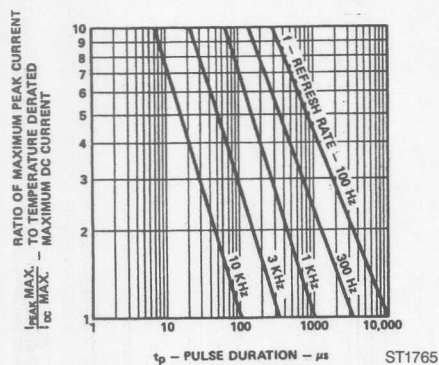


Fig. 5. Maximum Peak Current
vs. Pulse Duration

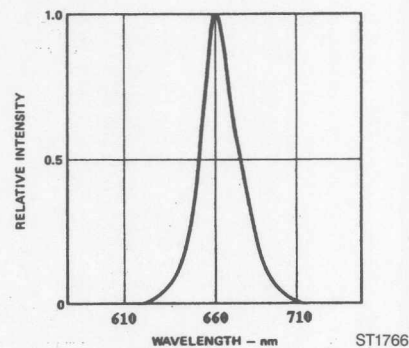


Fig. 6. Relative Intensity
vs. Wavelength

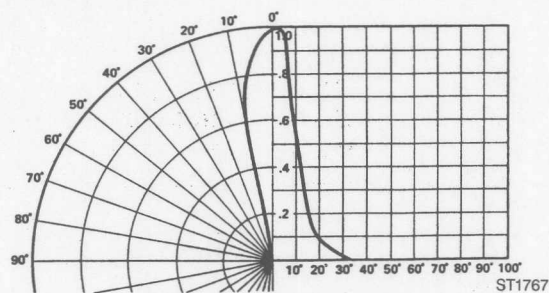
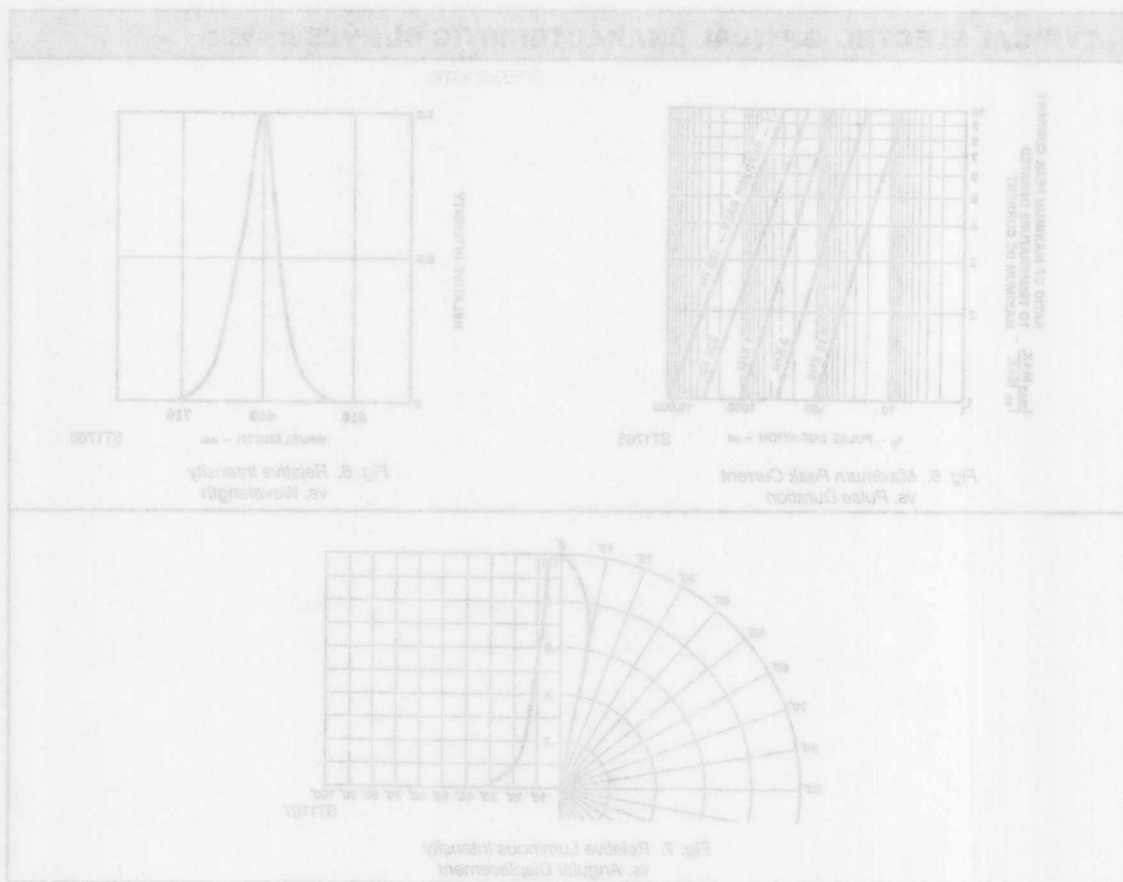
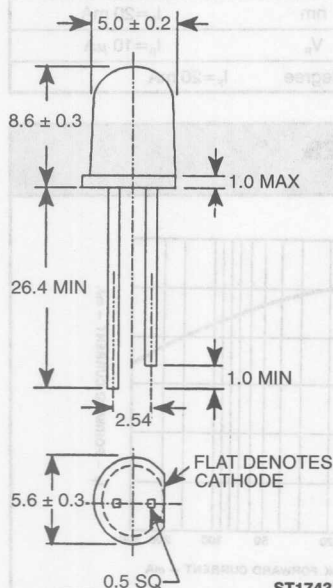


Fig. 7. Relative Luminous Intensity
vs. Angular Displacement



SUPER RED MV8111 CLEAR
SUPER RED MV8112 CLEAR
SUPER RED MV8113 CLEAR
SUPER RED MV8114 CLEAR

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
3. PROTRUDED RESIN UNDER FLANGE 1.5 mm (0.059 ") MAX

DESCRIPTION

These T-1 $\frac{3}{4}$ super bright LEDs have a narrow 12° viewing angle for concentrated light output. The MV8111 is made with a GaAlAs/GaAs LED and the MV8112/3/4 are made with GaAlAs LEDs on a GaAlAs substrate. They are all encapsulated in an epoxy package and have water clear lenses.

FEATURES

- Popular T-1 $\frac{3}{4}$ package
- Low drive current
- Solid state reliability
- Super high brightness suitable for outdoor application
- Standard 1 mil. lead spacing

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_F)	40 mA
Operating temperature range	-40°C to $+85^\circ$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time	5 seconds @ 260°C
(at $\frac{1}{16}$ inch from bottom of lamp)	
Peak forward current (I_P)	200 mA
(at $f=1.0$ KHz, Duty factor= $1/10$)	
Power dissipation (P_D)	110 mW
Recommended operating current (I_F Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity					
MV8111	250	370		mcd	$I_F = 20\text{ mA}$
MV8112	630	940		mcd	$I_F = 20\text{ mA}$
MV8113	1000	1500		mcd	$I_F = 20\text{ mA}$
MV8114	1600	2400		mcd	$I_F = 20\text{ mA}$
Forward voltage	1.5	1.7	2.4	V_F	$I_F = 20\text{ mA}$
Peak wavelength		660		nm	$I_F = 20\text{ mA}$
Spectral line half width		20		nm	$I_F = 20\text{ mA}$
Reverse breakdown voltage		5		V_R	$I_R = 10\text{ }\mu\text{A}$
Total viewing angle		12		degree	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

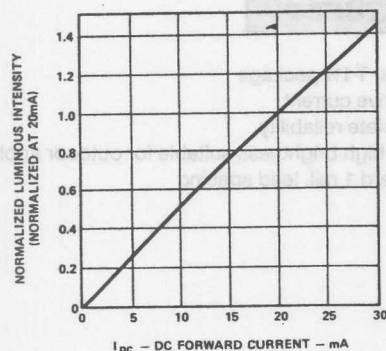


Fig. 1. Relative Luminous Intensity vs. DC Forward Current

ST1774

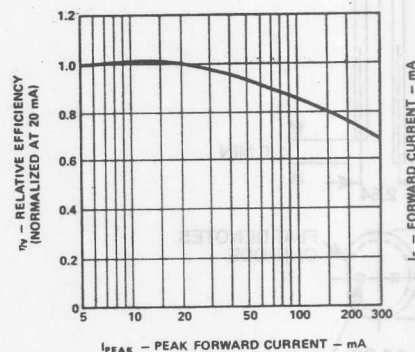


Fig. 2. Relative Efficiency vs. Peak Forward Current

ST1775

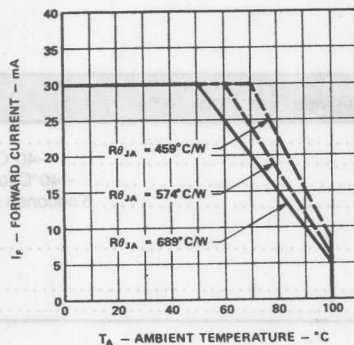


Fig. 3. Maximum Forward DC Current vs. Ambient Temperature Derating Based On $T_{JMAX} = 110^\circ$

ST1776

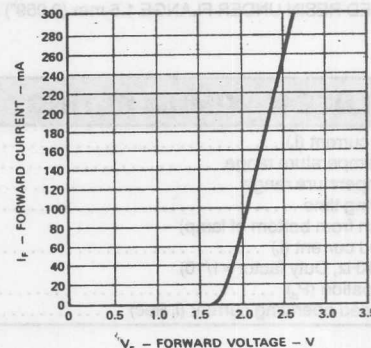


Fig. 4. Forward Current vs. Forward Voltage

ST1777

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

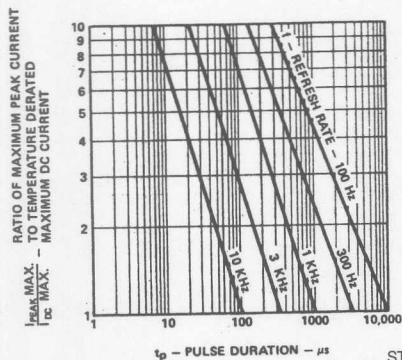


Fig. 5. Maximum Peak Current
vs. Pulse Duration

ST1778

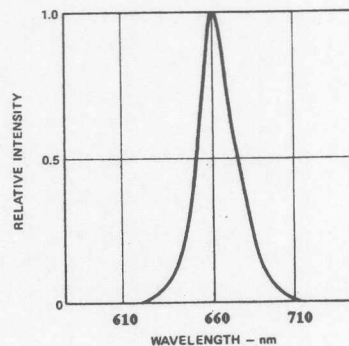


Fig. 6. Relative Intensity
vs. Wavelength

ST1779

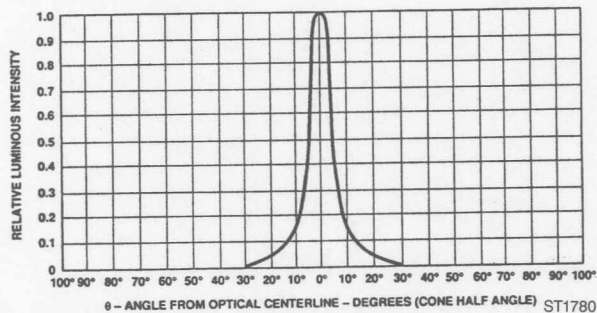
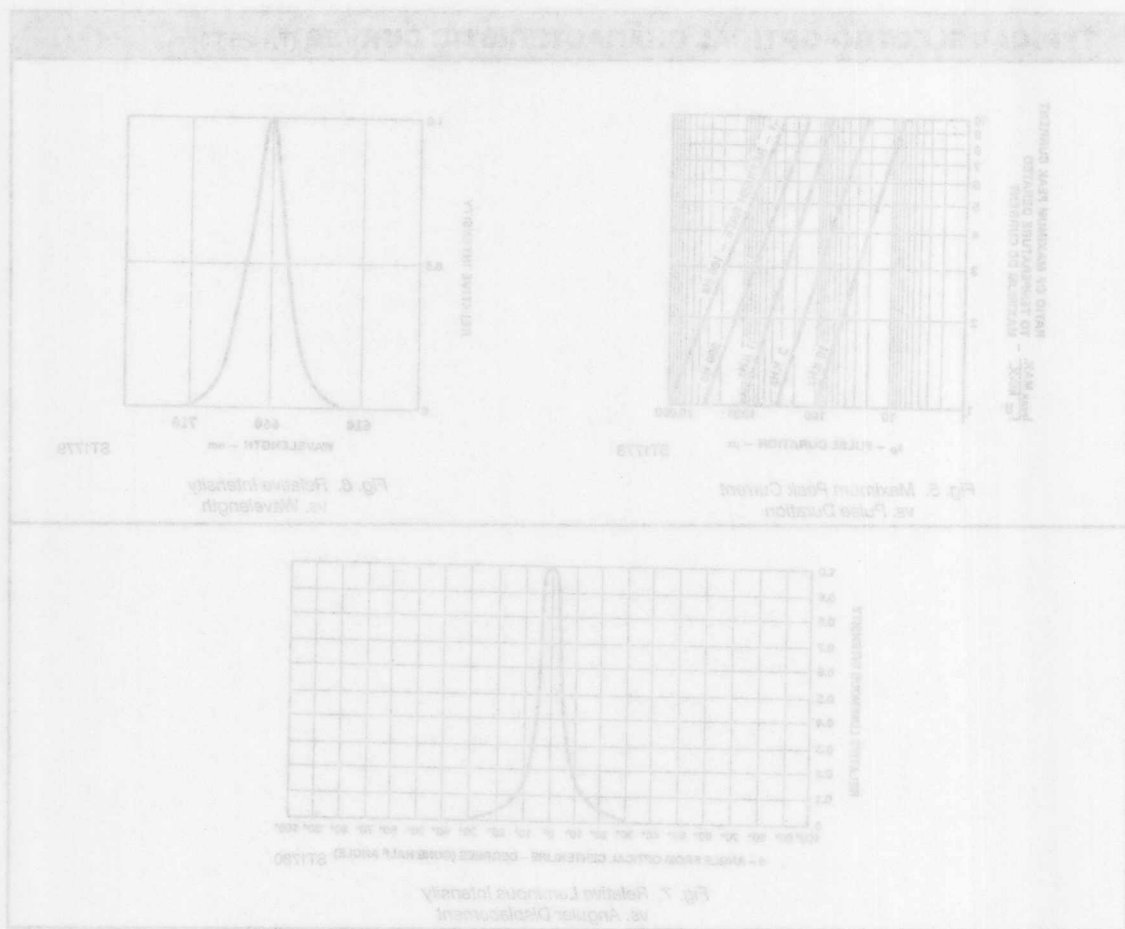


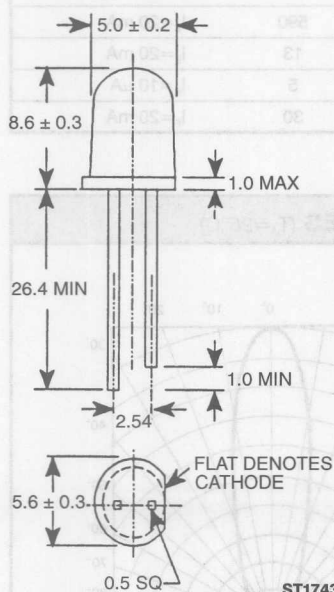
Fig. 7. Relative Luminous Intensity
vs. Angular Displacement

ST1780



SUPER RED MV8132 CLEAR
SUPER RED MV8133 CLEAR
SUPER YELLOW MV8332 CLEAR
SUPER YELLOW MV8333 CLEAR

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These T-1 $\frac{1}{4}$ super bright LEDs have a moderate 30° viewing angle. The MV8332/3 are made with an InGaAlP LED on a GaAs substrate and the MV8132/3 are made with a GaAlAs LED on a GaAlAs substrate. They are encapsulated in an epoxy package and have water clear lenses.

FEATURES

- Popular T-1 $\frac{1}{4}$ package
- Low drive current
- Solid state reliability
- Super high brightness suitable for outdoors applications
- Outstanding material efficiency

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_F)	
MV813X	40 mA
MV833X	30 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time (at $\frac{1}{16}$ inch from the bottom of lamp)	5 seconds @ 260°C
Peak forward current (I_F) (at $f=1.0$ KHz, Duty factor= 1/10)	
MV813X	200 mA
MV813X	160 mA
Power dissipation (P_d)	
MV813X	110 mW
MV813X	85 mW
Recommended operating current (I_F Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER	MV8132	MV8133	MV8332	MV8333	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 20\text{ mA}$
minimum	630	1000	630	1000	
typical	940	1500	940	1500	
maximum					
Forward voltage (V_F)					$I_F = 20\text{ mA}$
minimum	1.5	1.5	1.7	1.7	
typical	1.7	1.7	2.1	2.1	
maximum	2.4	2.4	2.8	2.8	
Peak wavelength (nm)	660	660	590	590	$I_F = 20\text{ mA}$
Spectral line half width (nm)	40	40	13	13	$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)	5	5	5	5	$I_F = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	30	30	30	30	$I_F = 20\text{ mA}$

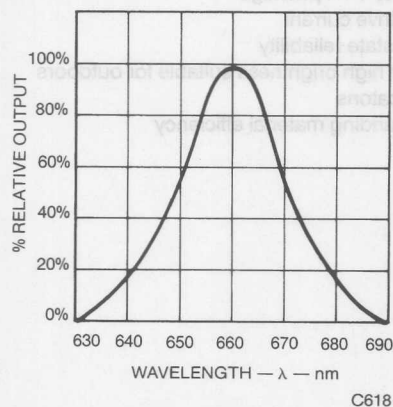
TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)**MV813X**

Figure 1. Relative Intensity vs. Wavelength

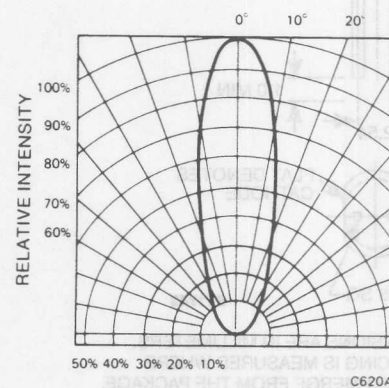


Figure 2. Relative Luminous Intensity vs. Angular Displacement

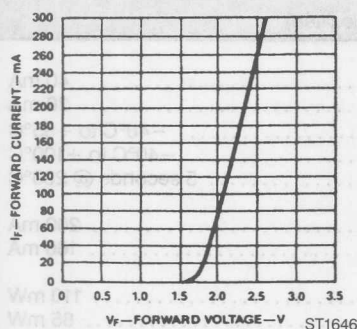


Figure 3. Forward Current vs. Forward Voltage

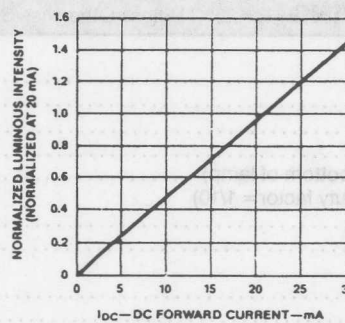


Figure 4. Relative Luminous Intensity vs. DC Forward Current

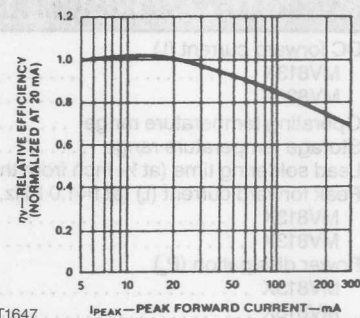
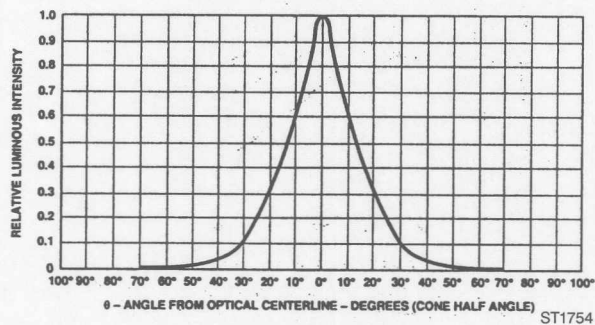
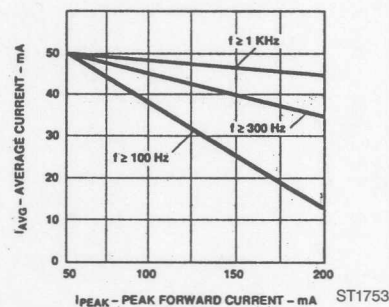
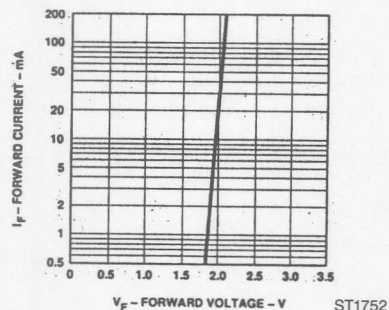
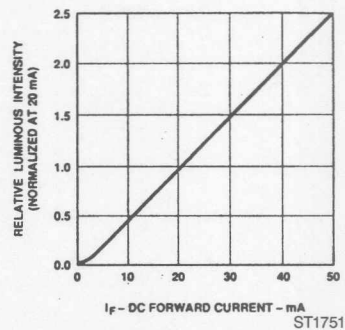
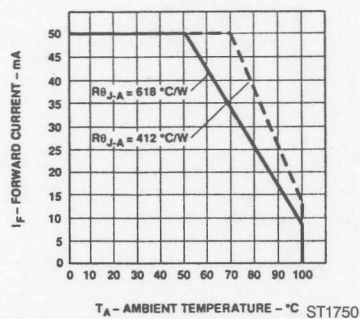
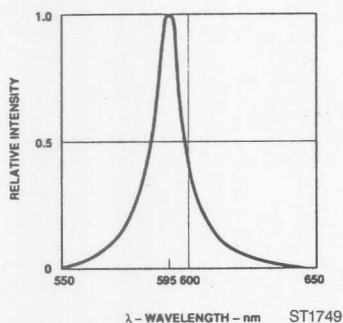
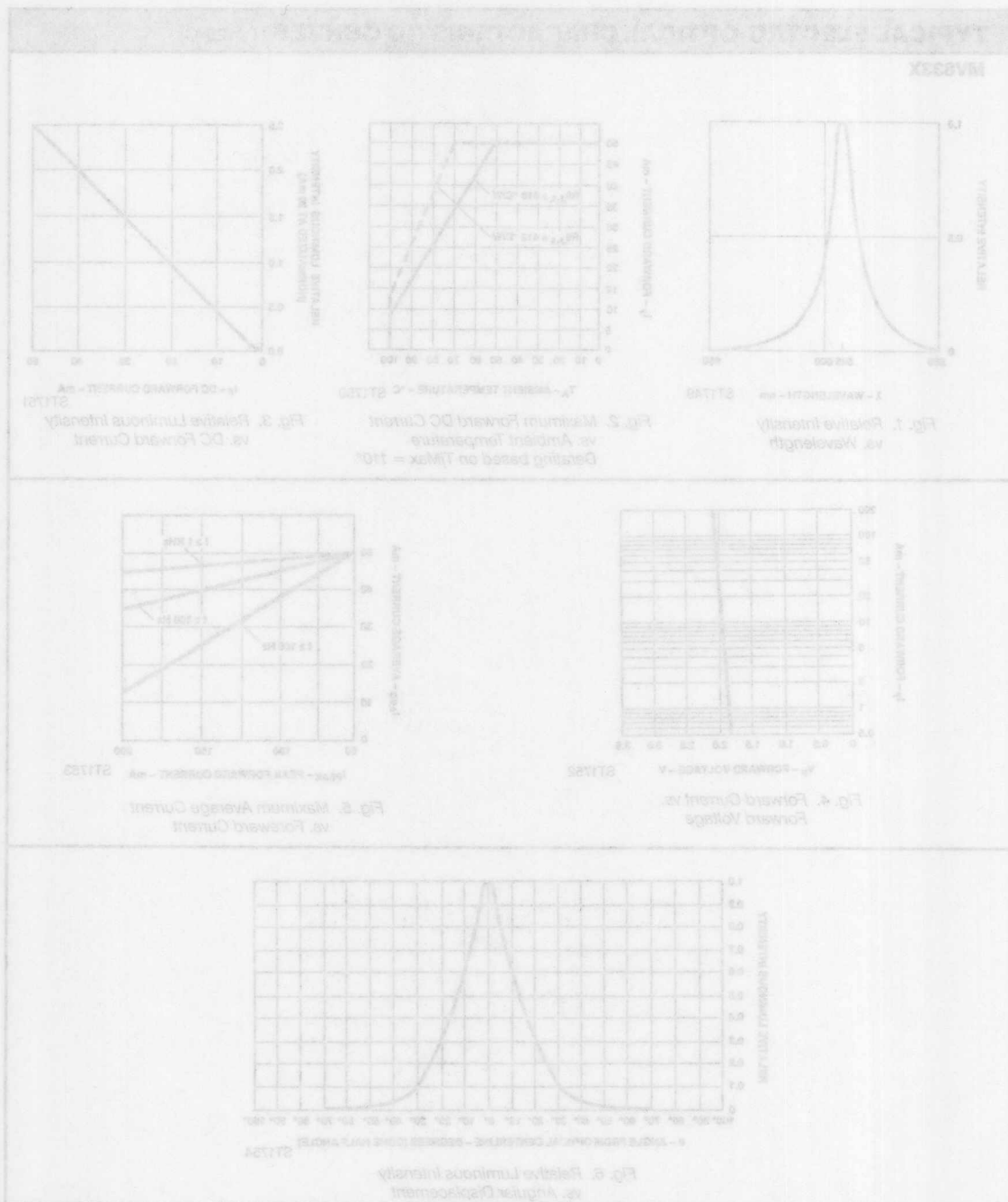


Figure 5. Relative Efficiency vs. Peak Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A=25^\circ\text{C}$)

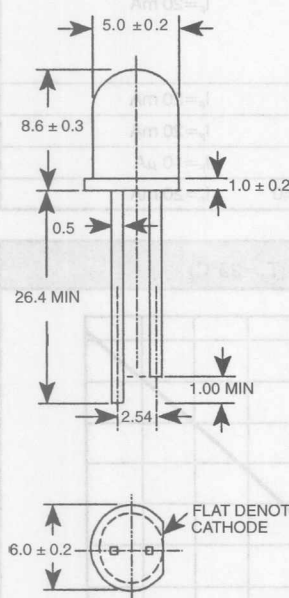
MV833X





SUPER RED MV8140 CLEAR SUPER RED MV8190 DIFFUSED
SUPER RED MV8141 CLEAR SUPER RED MV8191 DIFFUSED

PACKAGE DIMENSIONS



ST1683

NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These T-1¾ super bright LEDs have a moderate 40° or 45° viewing angle. The MV8190/1 are 40° and the MV8140/1 are 45°. All are made with GaAlAs LEDs on a GaAlAs substrate. They are encapsulated in an epoxy package. The MV8140/1 have a water clear lens while the MV8190/1 have a red diffused lens.

FEATURES

- Outstanding material efficiency.
- Popular T-1¾ package.
- Low drive current.
- Solid state reliability.
- Super high brightness.
- Standard 1 mil. lead spacing.

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_F)	40 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time	5 seconds @ 260°C
(at 1/16 inch from the bottom of lamp)	
Peak forward current (I_P)	200 mA
(at $f = 1.0$ KHz, Duty factor = 1/10)	
Power dissipation (P_d)	110 mW
Recommended operating current (I_R)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER	MV8190	MV8191	MV8140	MV8141	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 20\text{ mA}$
minimum	63	100	120	250	
typical	100	200	220	370	
maximum					
Forward voltage (V_F)					$I_F = 20\text{ mA}$
minimum			1.5		
typical			1.7		
maximum			2.4		
Peak wavelength (nm)			660		$I_F = 20\text{ mA}$
Spectral line half width (nm)			40		$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)			5		$I_F = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	45	45	40	40	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

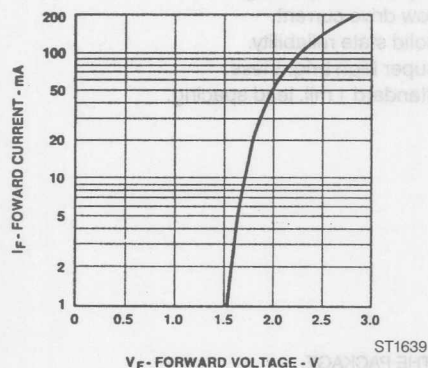


Fig. 1. Forward Current vs. Forward Voltage

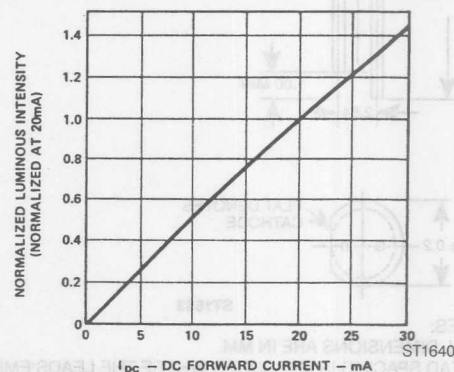


Fig. 2. Relative Luminous Intensity vs. Forward Current

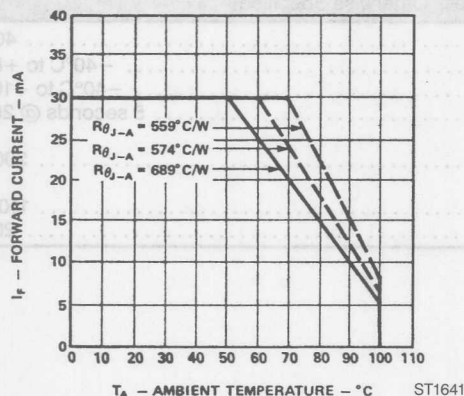


Fig. 3. Maximum Forward DC Current vs. Ambient Temperature Derating based on $T_{j\text{ MAX}} = 110^\circ$.

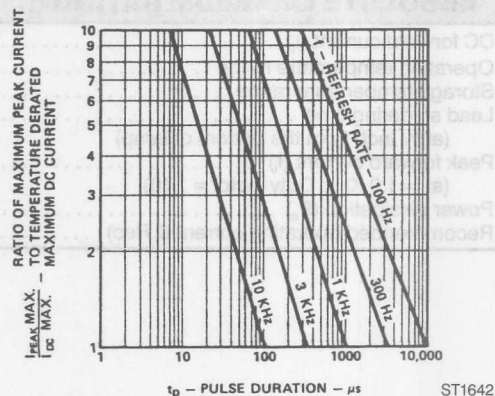


Fig. 4. Maximum Peak Current vs. Pulse Duration

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

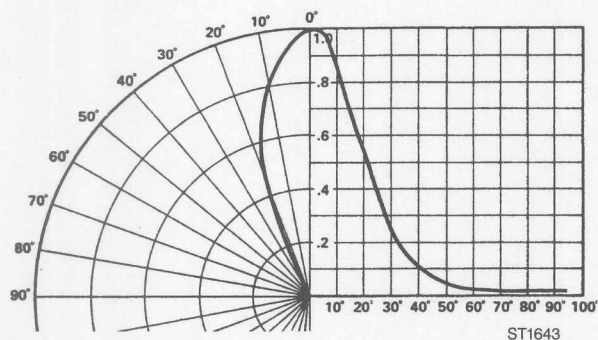


Fig. 5. Relative Luminous Intensity vs. Angular Displacement MV8190/1

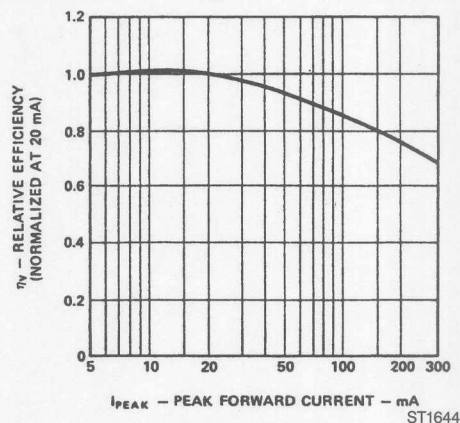


Figure 6. Relative Efficiency vs. Peak Forward Current

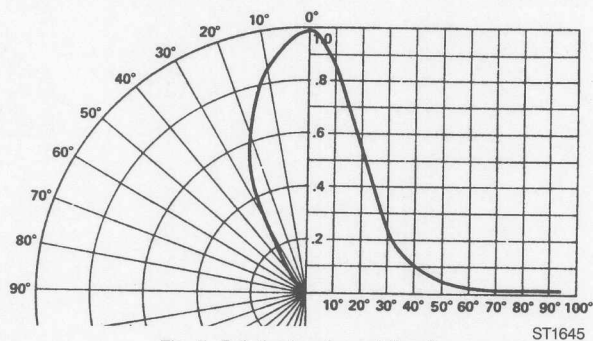
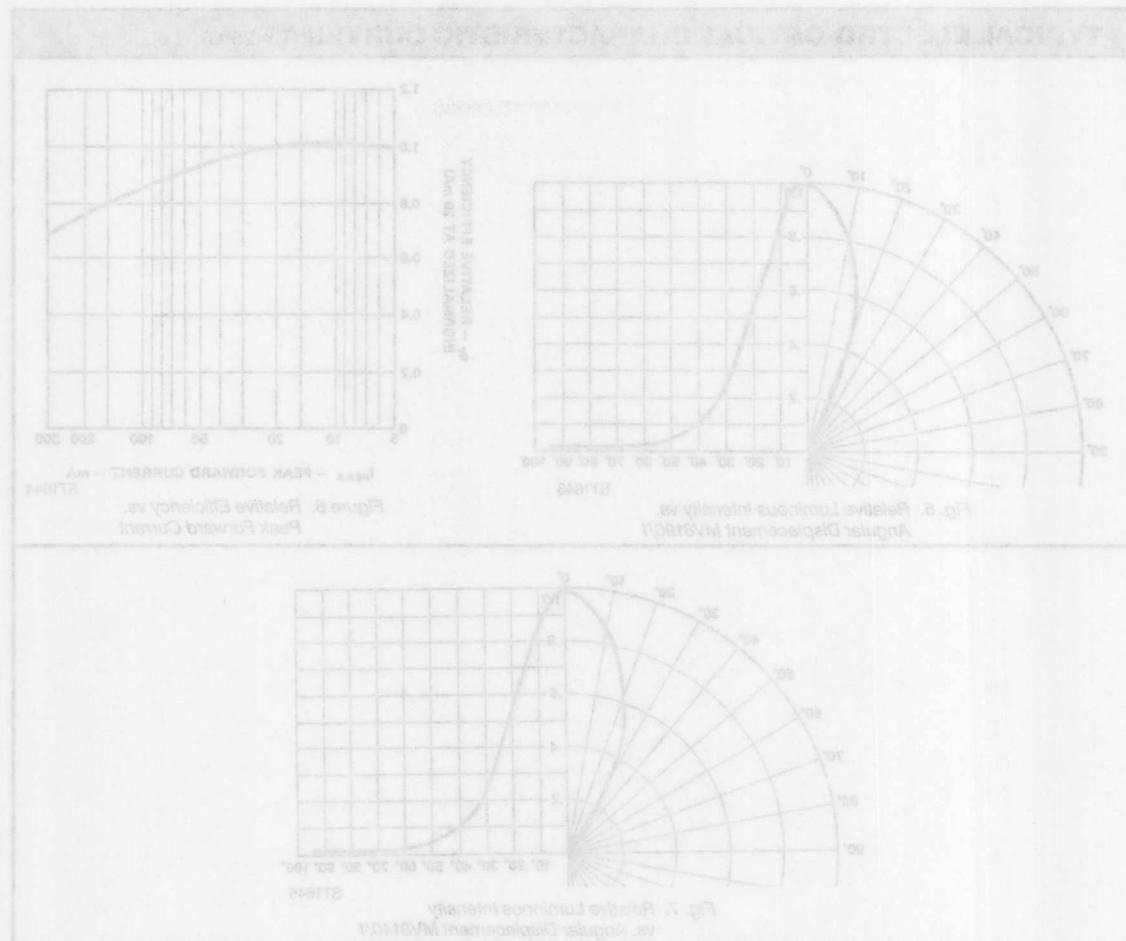
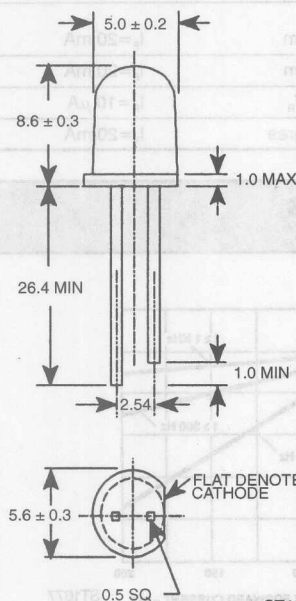


Fig. 7. Relative Luminous Intensity vs. Angular Displacement MV8140/1



**SUPER YELLOW MV8313 CLEAR
SUPER YELLOW MV8314 CLEAR**

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
3. PROTRUDED RESIN UNDER FLANGE IS 1.5 mm (0.059") MAX

DESCRIPTION

These T-1 $\frac{1}{4}$ super bright LEDs have a narrow 12° viewing angle for concentrated light output. The MV831X emit yellow light at 590 nm. They are encapsulated in an epoxy package and have water clear lenses.

FEATURES

- Popular T-1 $\frac{1}{4}$ package
- Low drive current
- Solid state reliability
- Super high brightness suitable for outdoors applications
- Standard 1 mil. lead spacing

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_F)	
MV831X	30 mA
Operating temperature range	-40°C to $+85^\circ$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time	5 seconds @ 260°C
(at $\frac{1}{16}$ inch from bottom of lamp)	
Peak forward current (I_P)	160 mA
(at $f=1.0$ KHz, Duty factor=1/10)	
Power dissipation (P_D)	
MV831X	85 mW
Recommended operating current (I_F Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity					
MV8313	630	940		mcd	$I_F = 20\text{ mA}$
MV8314	1000	1500		mcd	$I_F = 20\text{ mA}$
Forward voltage	1.7	2.1	2.8	V_F	$I_F = 20\text{ mA}$
Peak wavelength		590		nm	$I_F = 20\text{ mA}$
Spectral line half width		13		nm	$I_F = 20\text{ mA}$
Reverse breakdown voltage		5		V_R	$I_R = 10\text{ }\mu\text{A}$
Total viewing angle		12		degree	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

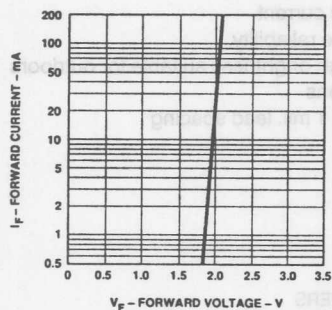


Fig. 1. Forward Current vs. Forward Voltage

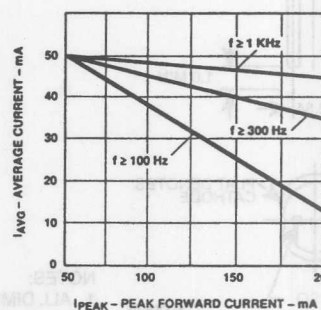


Fig. 2. Maximum Average Current vs. Peak Forward Current

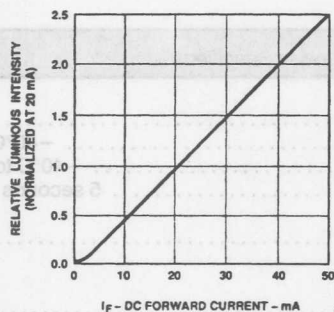


Fig. 3. Relative Luminous Intensity vs. Forward Current

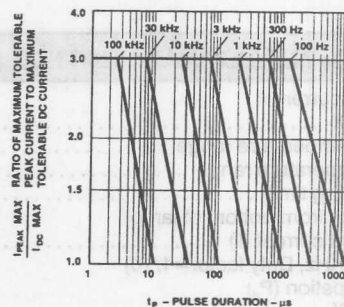


Fig. 4. Maximum Peak Current vs. Pulse Duration

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

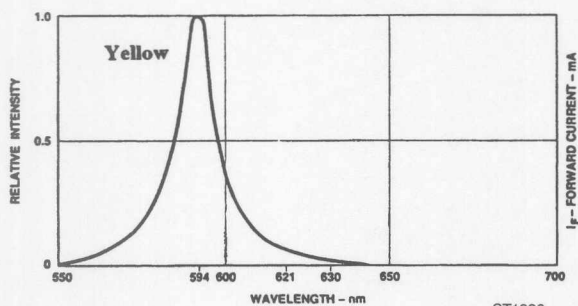


Fig. 5. Relative Intensity vs. Wavelength

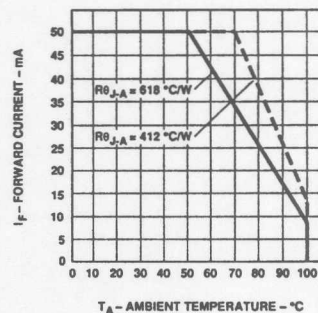


Fig. 6. Maximum Forward DC Current vs. Ambient Temperature Derating Based On $T_{JMAX} = 110^\circ$

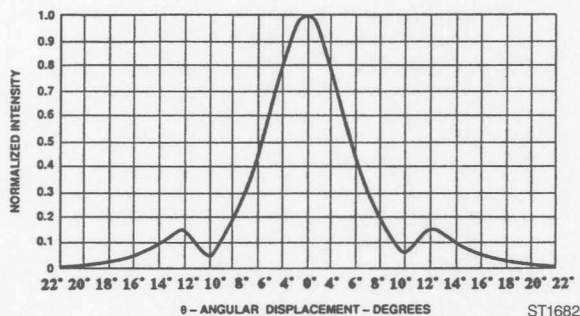
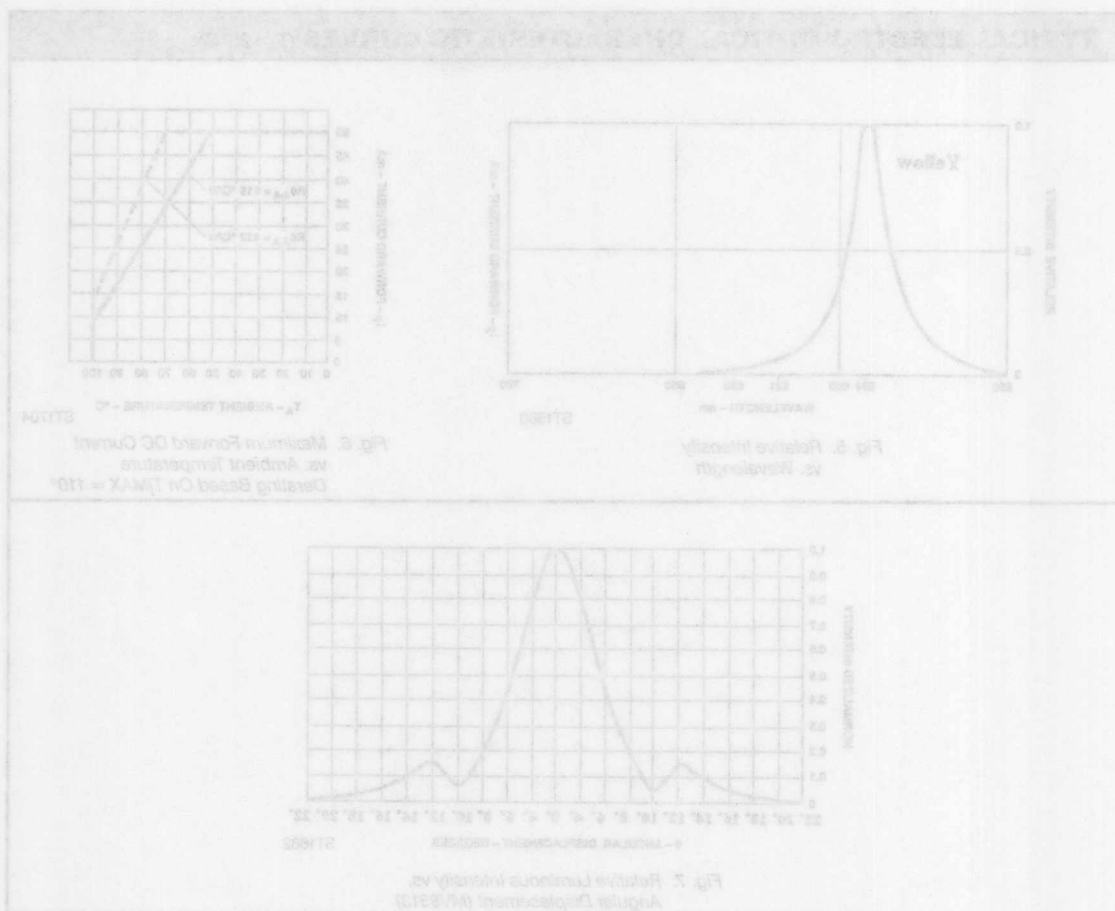
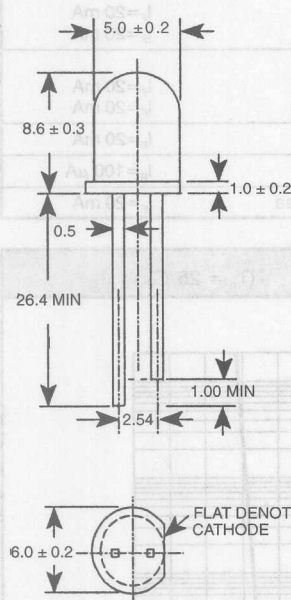


Fig. 7. Relative Luminous Intensity vs. Angular Displacement (MV8313)



**SUPER YELLOW MV8341 CLEAR
SUPER YELLOW MV8342 CLEAR**

PACKAGE DIMENSIONS



NOTES:

1. ALL DIMENSIONS ARE IN INCHES MILLIMETERS
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX

DESCRIPTION

These T-1¼ super bright LEDs have a moderate 45° viewing angle for consistent light output. They are suitable as an indicator or for back lighting in high ambient light situations. The MV8341/2 are made with InGaAlP LEDs on a GaAs substrate. All are encapsulated in an epoxy package and have a water clear lens.

FEATURES

- Outstanding material efficiency
- Popular T-1¼ package
- Low drive current
- Solid state reliability
- Super high brightness
- Standard 1 mil. lead spacing

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_F)	30 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time (at $\frac{1}{16}$ inch from the bottom of lamp)	5 seconds @ 260°C
Peak forward current (I_P) (at $f = 1.0$ KHz, Duty factor = $1/10$)	160 mA
Power dissipation (P_d)	85 mW
Recommended operating current (I_F Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Luminous intensity					
MV8341	160	220		mcd	$I_F = 20\text{ mA}$
MV8342	250	370		mcd	$I_F = 20\text{ mA}$
Forward voltage					
MV8341	1.7	2.1	2.8	V_F	$I_F = 20\text{ mA}$
MV8342	1.7	2.1	2.8	V_F	$I_F = 20\text{ mA}$
Peak wavelength					
MV8341		660		nm	$I_F = 20\text{ mA}$
MV8342		590		nm	$I_F = 20\text{ mA}$
Spectral line half width		13		nm	$I_F = 20\text{ mA}$
Reverse breakdown voltage		5		V_R	$I_R = 100\text{ }\mu\text{A}$
Viewing angle		45		degree	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

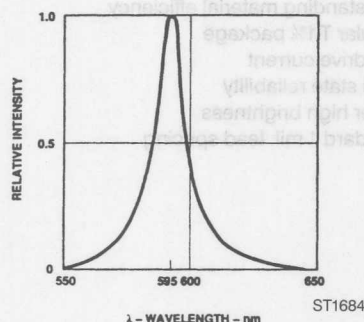


Fig. 1. Relative Intensity vs. Wavelength

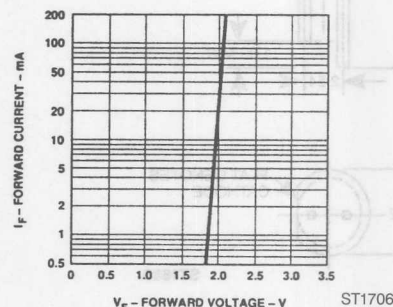


Fig. 2. Forward Current vs. Forward Voltage

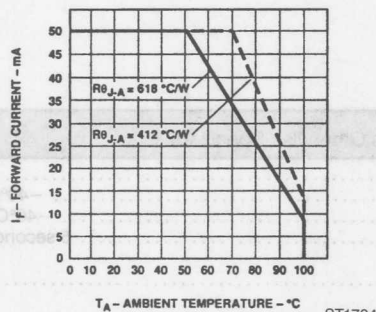


Fig. 3. Maximum Forward DC Current vs. Ambient Temperature
Derating based on $T_{J\text{Max}} = 110^\circ$

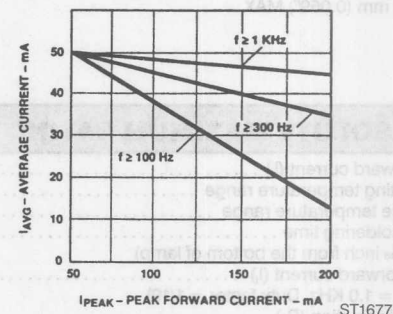


Fig. 4. Maximum Average Current vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

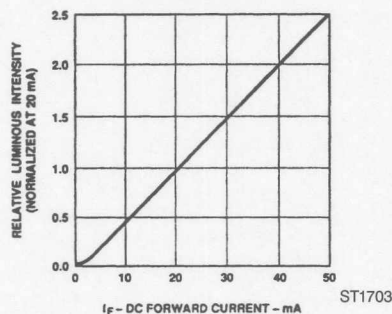


Fig. 5. Relative Luminous Intensity vs. DC Forward Current

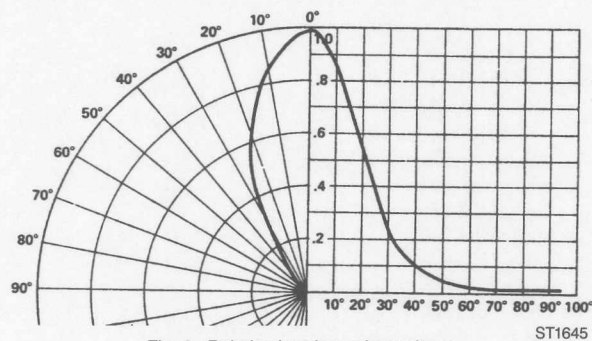


Fig. 6. Relative Luminous Intensity vs. Angular Displacement (MV8341/2)

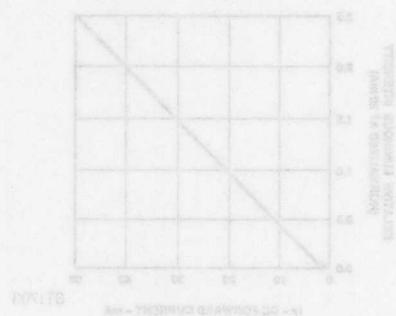


Fig. 5. Relative Luminous Intensity vs. DC Forward Current

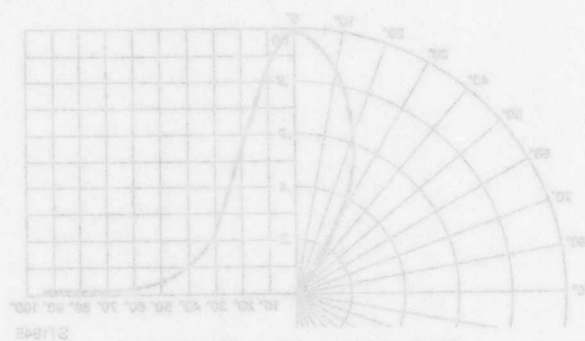
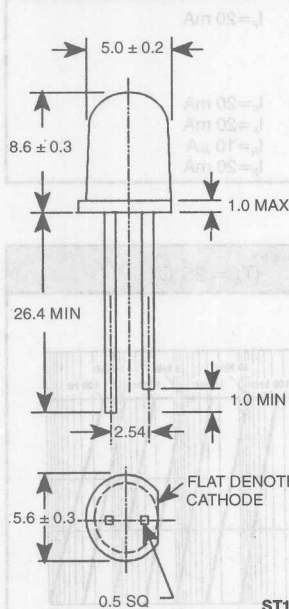


Fig. 6. Relative Luminous Intensity vs. Angular Displacement (at 100 mA)

**SUPER GREEN MV8410 CLEAR
SUPER GREEN MV8411 CLEAR**

PACKAGE DIMENSIONS



ST1690-02

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX

DESCRIPTION

These T-1 $\frac{3}{4}$ super bright LEDs have a narrow 12° viewing angle for concentrated light output. The MV8410/1 are made with GaP LEDs on a GaP substrate. They are encapsulated in an epoxy package and have a water clear lens.

FEATURES

- Popular T-1 $\frac{3}{4}$ package
- Low drive current
- Solid state reliability
- Super high brightness
- Standard 1 mil. lead spacing

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_F)	30 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time	5 seconds @ 260°C
(at $\frac{1}{16}$ inch from the bottom of lamp)	
Peak forward current (I_P)	160 mA
(at $f = 1.0$ KHz, Duty factor = 1/10)	
Power dissipation (P_D)	85 mW
Recommended operating current (I_F , Rec)	20 mA

6

MV8410 MV8411

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER	MV8410	MV8411	TEST CONDITIONS
Luminous intensity (mcd)			$I_F = 20\text{ mA}$
minimum	160	250	
typical	240	370	
maximum			
Forward voltage (V_F)			$I_F = 20\text{ mA}$
minimum		1.7	
typical		2.1	
maximum		2.8	
Peak wavelength (nm)		565	$I_F = 20\text{ mA}$
Spectral line half width (nm)		30	$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)		5	$I_R = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)		12	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

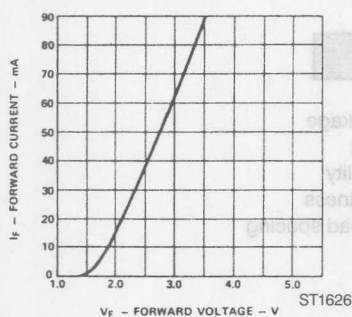


Fig. 1. Forward Current vs. Forward Voltage

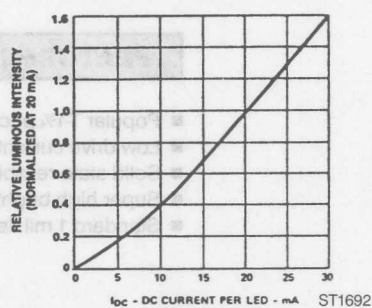


Fig. 2. Relative Luminous Intensity vs. Forward Current

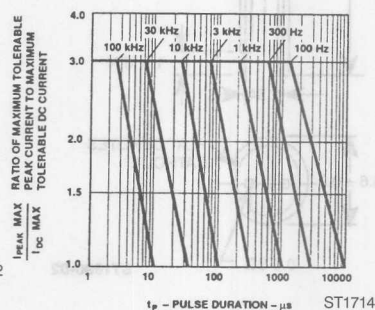


Fig. 3. Maximum Peak Current vs. Pulse Duration

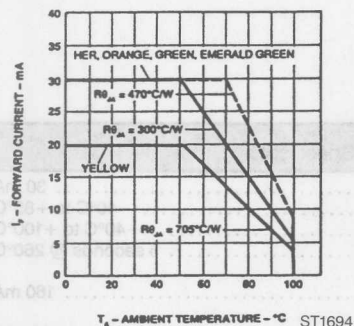


Fig. 4. Maximum Forward DC Current vs. Ambient Temperature
Derating based on $T_{J\text{Max}} = 110^\circ$

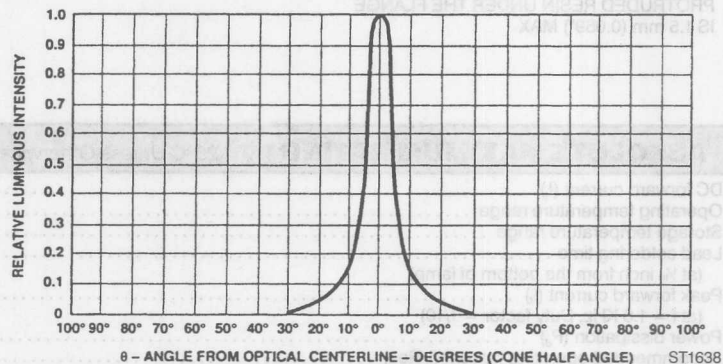
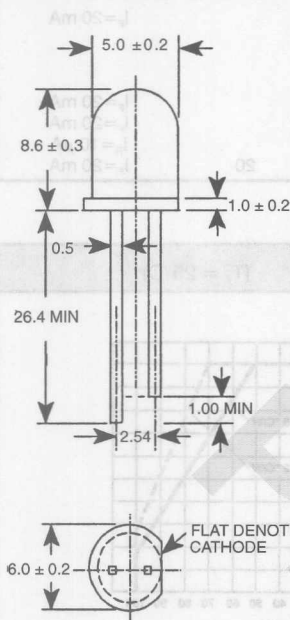


Fig. 5. Relative Luminous Intensity vs. Angular Displacement

SUNSET ORANGE MV8741 CLEAR
SUNSET ORANGE MV8742 CLEAR

SUNSET ORANGE MV8703 CLEAR
SUNSET ORANGE MV8704 CLEAR

PACKAGE DIMENSIONS



- NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS
 2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE
 3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX

DESCRIPTION

These T-1 $\frac{1}{4}$ super bright LEDs have either a narrow 20°, or a moderate 45° viewing angle. The MV8703/4 and the MV8741/2 are made with InGaAlP LEDs on a GaAs substrate that emit orange light at 620 nm. They are encapsulated in an epoxy package and have a water clear lens.

FEATURES

- Outstanding material efficiency
- Popular T-1 $\frac{1}{4}$ package
- Low drive current
- Solid state reliability
- Super high brightness suitable for outdoors applications
- Standard 1 mil. lead spacing

6

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_f)	50 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time (at $\frac{1}{16}$ inch from the bottom of lamp)	5 seconds @ 260°C
Peak forward current (I_p) (at $f = 1.0$ KHz, Duty factor = $1/10$)	160 mA
Power dissipation (P_d)	100 mW
Recommended operating current (I_f , Rec)	20 mA

MV8741 MV8742 MV8703 MV8704

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER	MV8741	MV8742	MV8703	MV8704	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 20\text{ mA}$
minimum	250	400	630	1000	
typical	370	600	940	1500	
maximum					
Forward voltage (V_F)					$I_F = 20\text{ mA}$
minimum			1.7		
typical			2.1		
maximum			2.8		
Peak wavelength (nm)			620		$I_F = 20\text{ mA}$
Spectral line half width (nm)			18		$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)			5		$I_R = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	45	45	20	20	$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

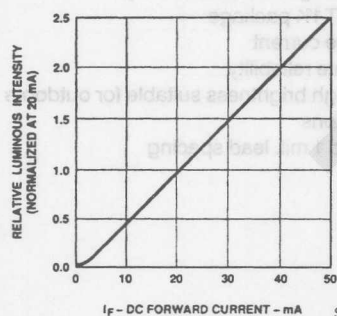


Fig. 1. Relative Luminous Intensity vs. DC Forward Current

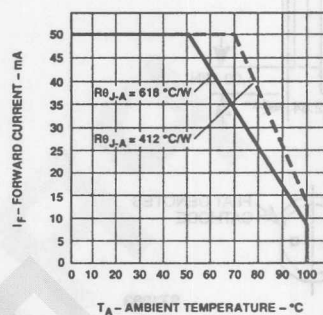
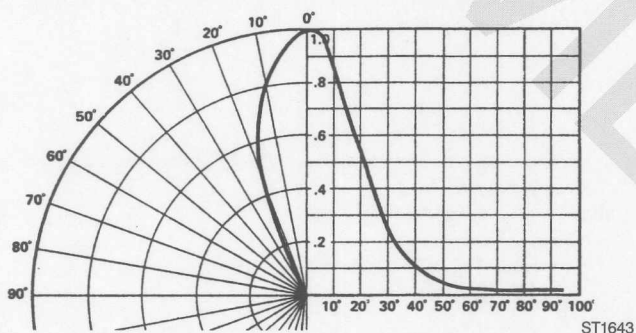
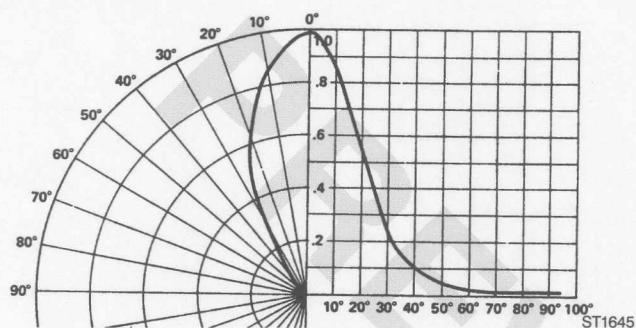
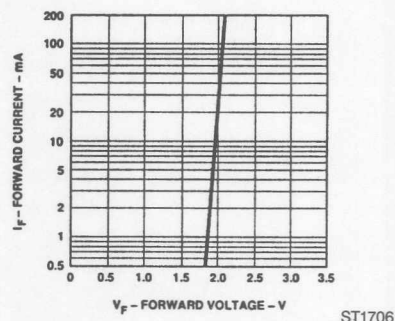
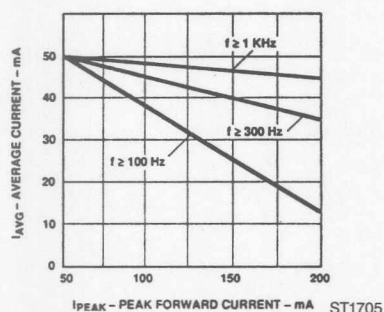


Fig. 2. Maximum Forward DC Current vs. Ambient Temperature
Derating based on $T_{JMAX} = 110^\circ$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)



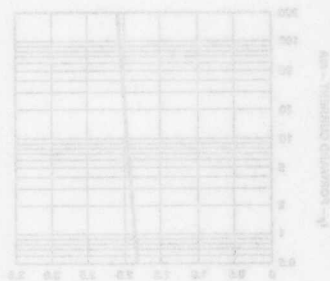


Fig. 4. Forward Current vs. Forward Voltage
ST1708

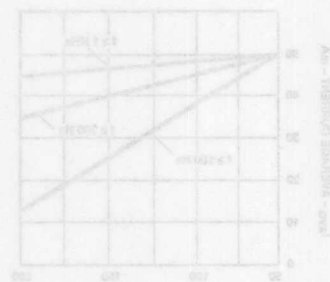


Fig. 3. Relative Intensity vs. Peak Forward Current
ST1708

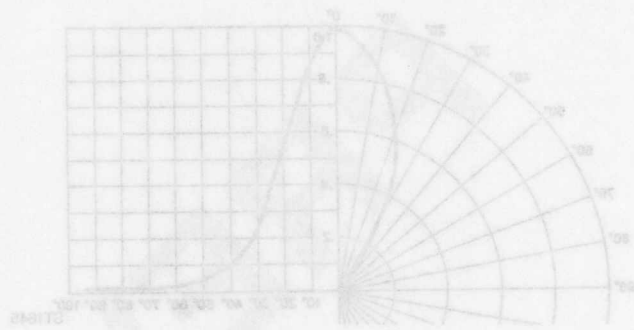


Fig. 5. Relative Luminous Intensity vs. Angular Displacement MVDX
ST1708

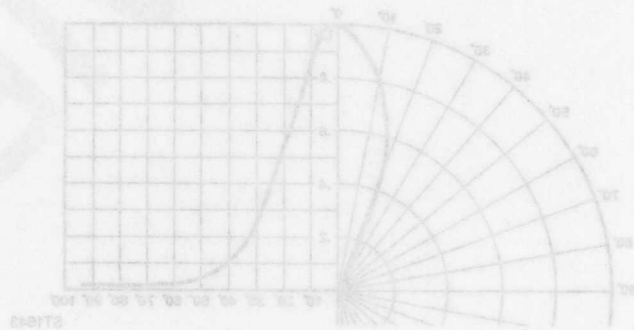
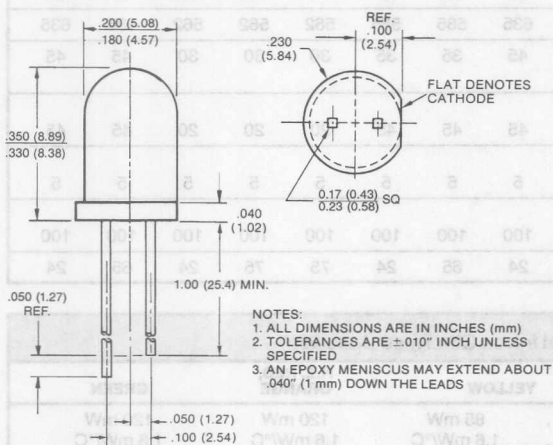


Fig. 6. Relative Luminous Intensity vs. Angular Displacement MVDX
ST1708

ORANGE MV5153/4A MV6153/4A
YELLOW MV5353/4A MV6353/4A
HIGH EFFICIENCY GREEN MV5453/4A MV64530/1 MV6454A
HIGH EFFICIENCY RED MV5753/4A MV6753/4A

PACKAGE DIMENSIONS



DESCRIPTION

These solid state indicators offer a variety of diffused lens effects and color availability. The High Efficiency Red and Yellow devices are made with gallium arsenide phosphide on gallium phosphide. The Green units are made with gallium phosphide on gallium phosphide. All devices are available with cathode long as MV5X5X, or with anode long as MV6X5X.

FEATURES

- High efficiency GaP light source with various lens effects
- Versatile mounting on PC board or panel
- Snap in grommet MP52 available as separate order item
- Long life—solid state reliability
- Low power requirements
- Compact, rugged, lightweight

PHYSICAL CHARACTERISTICS

CATHODE LONG	ANODE LONG	SOURCE COLOR	LENS TYPE	LENS EFFECT	APPLICATION
MV5153	MV6153	High Efficiency Red	Amber Diffused	Wide Beam	Direct View
MV5154A	MV6154A	High Efficiency Red	Amber Diffused	Narrow Beam	High Bright Direct View
MV5353	MV6353	Yellow	Yellow Diffused	Wide Beam	Direct View
MV5354A	MV6354A	Yellow	Yellow Diffused	Narrow Beam	High Bright Direct View
MV5453	MV64530/1	High Efficiency Green	Green Diffused	Wide Beam	Direct View
MV5454A	MV6454A	High Efficiency Green	Green Diffused	Narrow Beam	High Bright Direct View
MV5753	MV6753	High Efficiency Red	Red Diffused	Wide Beam	Direct View
MV5754A	MV6754A	High Efficiency Red	Red Diffused	Narrow Beam	High Bright Direct View

ELECTRO-OPTICAL CHARACTERISTICS (25°C Free Air Temperature)

PARAMETER	TEST COND.	UNITS	6153 5153	6154A 5154A	6353 5353	6354A 5354A	64530 5453	64531	6454A 5454A	6753 5753	6754A 5754A
Forward voltage (V_F)											
typ.	$I_F=20$ mA	V	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.0	2.0
max.	$I_F=20$ mA	V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Luminous Intensity											
min.	$I_F=20$ mA	mcd	3.0	10.0	2.5	10.0	3.0	7.0	10.0	3.0	10.0
typ.	$I_F=20$ mA	mcd	15	25	15	25	20	20	30	15	25
Peak wavelength	$I_F=20$ mA	nm	635	635	585	585	562	562	562	635	635
Spectral line half width	$I_F=20$ mA	nm	45	45	35	35	30	30	30	45	45
Capacitance											
typ.	$V=0, f=1$ MHz	pF	45	45	45	45	20	20	20	45	45
Reverse voltage (V_R)											
min.	$I_R=100$ μ A	V	5	5	5	5	5	5	5	5	5
Reverse current (I_R)											
max.	$V_R=5.0$ V	μ A	100	100	100	100	100	100	100	100	100
Viewing angle (total)	See Fig. 3	degrees	65	24	65	24	75	75	24	65	24

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

	YELLOW	H.E. RED, ORANGE	GREEN
Power dissipation at 25°C ambient	85 mW	120 mW	120 mW
Derate linearly from 25°C (MVX453/4A from 50°C)	1.6 mW/°C	1.6 mW/°C	1.6 mW/°C
Storage and operating temperatures	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Lead soldering time at 260°C (See Note 2)	5 sec.	5 sec.	5 sec.
Continuous forward current at 25°C	20 mA	35 mA	30 mA
Peak forward current (1 μ sec pulse, 0.3% duty cycle)	60 mA	1.0 A	90 mA
Reverse voltage	5.0 V	5.0 V	5.0 V

NOTES

- The axis of spatial distribution are typically within a 10° cone with reference to the central axis of the device.
- The leads of the device were immersed in molten solder, at 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with a dwell time of 5 seconds.

APPLICATION	LEAD PATTERN	LEAD TYPE	PACKAGE TYPE	PACKAGE PART NO.	PACKAGE PART NO.
Direct View	Wide Beam	Amber Diffused	High Efficiency Red	MV5153	MV5153
High Bright Direct View	Narrow Beam	Amber Diffused	High Efficiency Red	MV5154A	MV5154A
Direct View	Wide Beam	Yellow Diffused	Yellow	MV5353	MV5353
High Bright Direct View	Narrow Beam	Yellow Diffused	Yellow	MV5354A	MV5354A
Direct View	Wide Beam	Green Diffused	High Efficiency Green	MV54530	MV54530
High Bright Direct View	Narrow Beam	Green Diffused	High Efficiency Green	MV5454A	MV5454A
Direct View	Wide Beam	Red Diffused	High Efficiency Red	MV5753	MV5753
High Bright Direct View	Narrow Beam	Red Diffused	High Efficiency Red	MV5754A	MV5754A

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

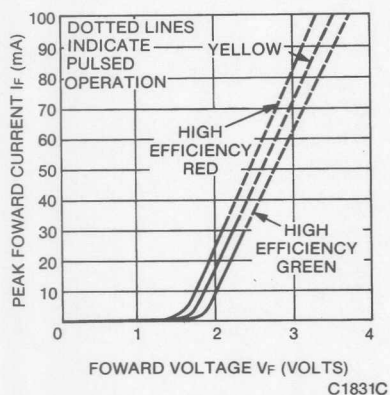


Fig. 1. Forward Current vs. Forward Voltage

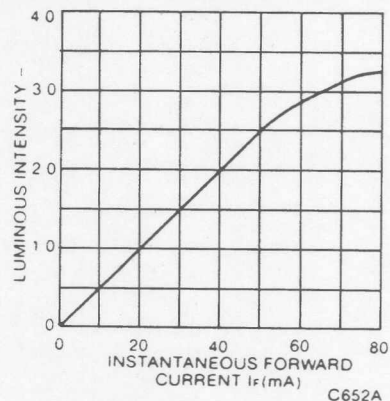


Fig. 2. Luminous Intensity vs. Forward Current

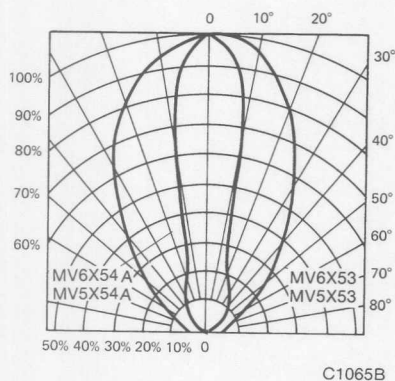


Fig. 3. Spatial Distribution (See Note 1)

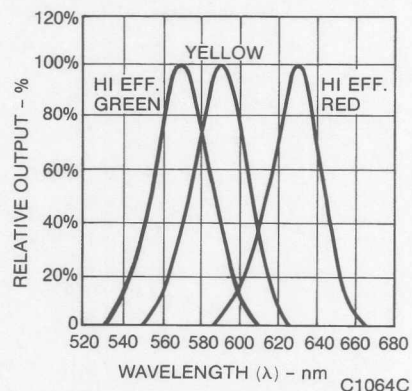


Fig. 4. Spectral Distribution

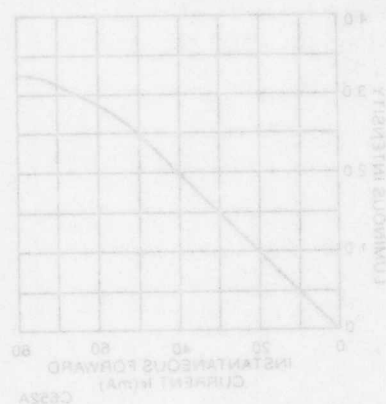


Fig. 2: Luminous intensity vs. Forward Current

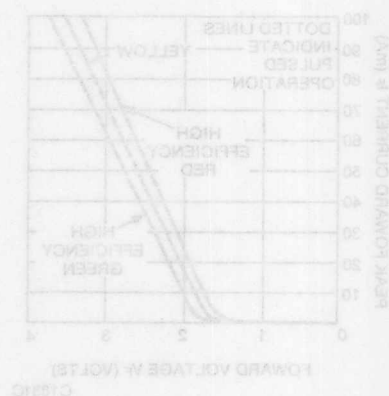


Fig. 1: Forward Current vs. Forward Voltage

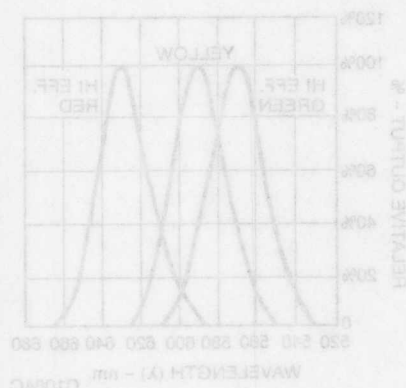


Fig. 4: Spectral Distribution

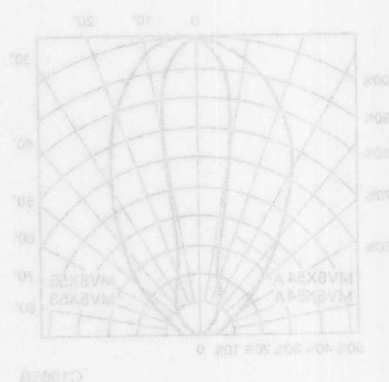
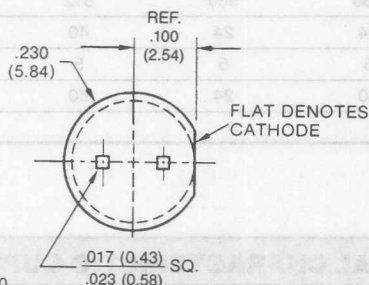


Fig. 3: Spatial Distribution (See Note 1)



NOTES:

- NOTES:
1. ALL DIMENSIONS ARE IN INCHES (mm)
2. TOLERANCES ARE $\pm .010$ " INCH UNLESS SPECIFIED
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .040" (1 mm) DOWN THE LEADS

C1062F

These T-1 $\frac{3}{4}$ LEDs are widely used as general purpose indicators. The pure green lamps are made with a GaP LEDs on a GaP substrate. The soft orange are made with GaAsP LEDs on a GaP substrate. They are encapsulated in epoxy packages and are designed to provide superior light output and a wide viewing angle.

- Popular T-1½ package
- Low drive current
- Solid state reliability
- Wide viewing angle
- Choice of pure green or soft orange colors

DC forward current (I_f)	40 mA
Operating temperature range	-40°C to +85°C
Storage temperature range	-40°C to +100°C
Lead soldering time (at 1/16 inch from the bottom of lamp)	5 seconds @ 260°C
Peak forward current (I_p) (at f=1.0 KHz, Duty factor= 1/10)	200 mA
Power dissipation (P_d)	110 mW
Recommended operating current (I_{Rec})	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER HLMP-	D600	D640*	D400	D401	TEST CONDITIONS
Luminous intensity (mcd)					$I_F = 10\text{ mA}$
minimum	1.0	6.7	2.1	4.0	
typical	3.0	60	3.5	7.0	
Forward voltage (V_F)					$I_F = 10\text{ mA}$
minimum			1.5	1.5	
typical	2.1	2.2	1.9	1.9	
maximum	2.7	3.0	2.4	2.4	
Peak wavelength (nm)	560	560	612	612	$I_F = 10\text{ mA}$
Spectral line half width (nm)	24	24	40	40	$I_F = 10\text{ mA}$
Reverse breakdown voltage (V_R)	5	5	5	5	$I_F = 100\text{ }\mu\text{A}$
Viewing angle ($^\circ$)	60	24	60	60	$I_F = 10\text{ mA}$

*NOTE: HLMP-D640 test condition is $I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

Pure (Emerald) Green

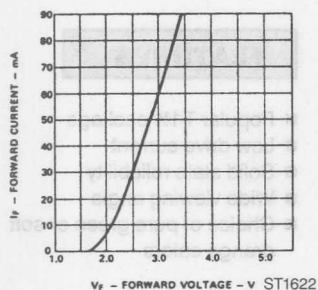


Figure 1. Forward Current vs. Forward Voltage

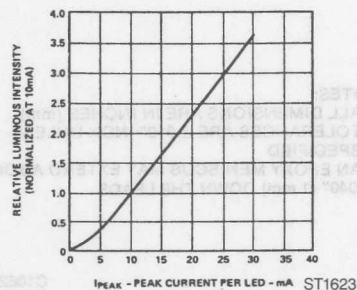


Figure 2. Relative Luminous Intensity vs. Forward Current

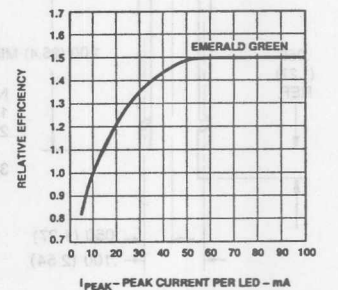


Figure 3. Relative Efficiency vs. Peak LED Current

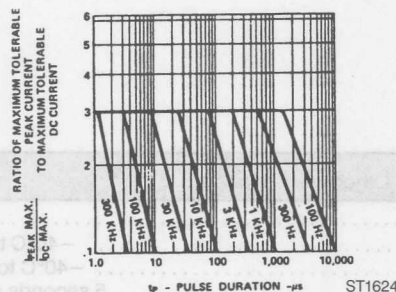


Figure 4. Maximum Peak Current vs. Pulse Duration

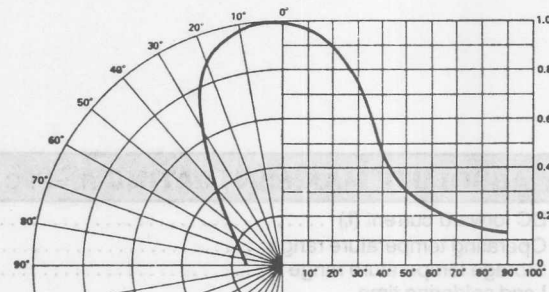


Figure 5. Relative Luminous Intensity vs. Angular Displacement

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A=25^\circ\text{C}$)

Soft Orange

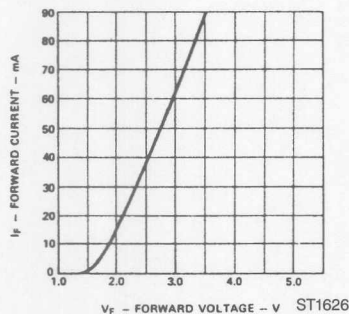


Figure 1. Forward Current vs. Forward Voltage

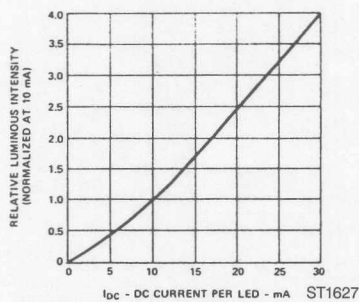


Figure 2. Relative Luminous Intensity vs. Forward Current

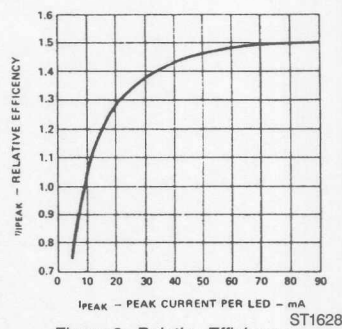


Figure 3. Relative Efficiency vs. Peak LED Current

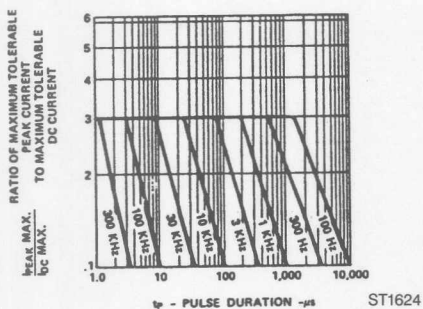


Figure 4. Maximum Peak Current vs. Pulse Duration

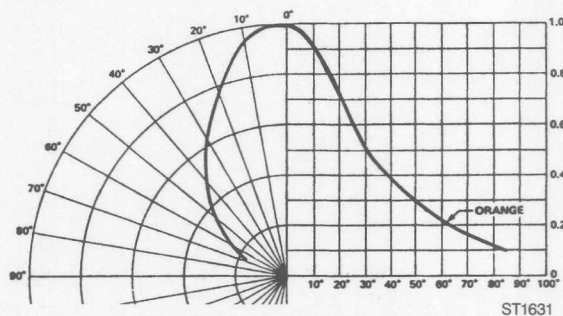


Figure 5. Relative Luminous Intensity vs. Angular Displacement

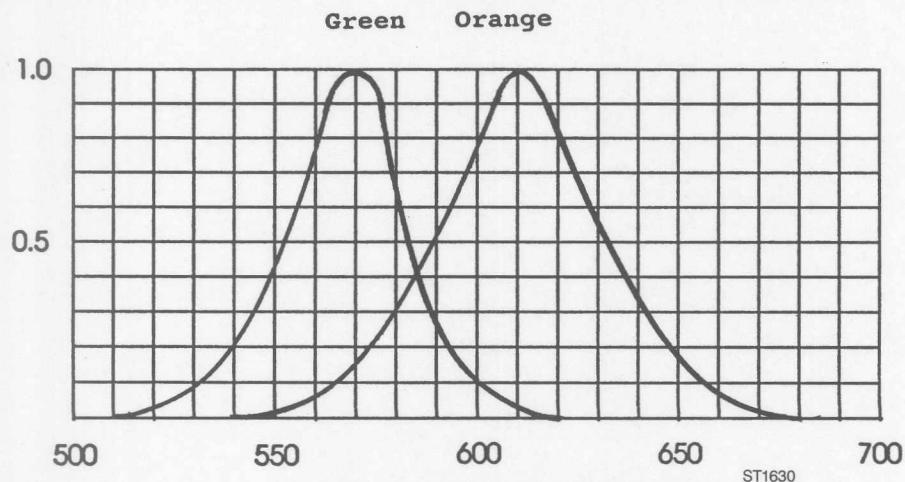


Fig. 6. Relative Intensity vs. Wavelength-nm

Soft Orange

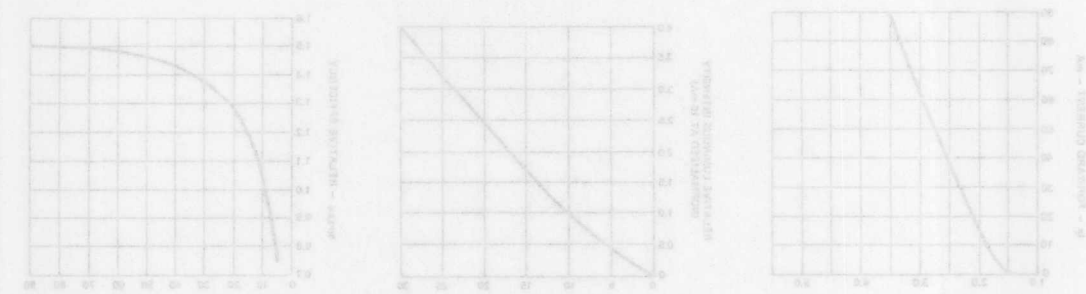


Figure 1: Forward Current vs. Forward Voltage
Figure 2: Relative Luminous Intensity vs. Forward Current
Figure 3: Relative Efficiency vs. Peak LED Current



Figure 4: Maximum Peak Current vs. Pulse Duration
Figure 5: Relative Luminous Intensity vs. Angular Displacement

Green Orange

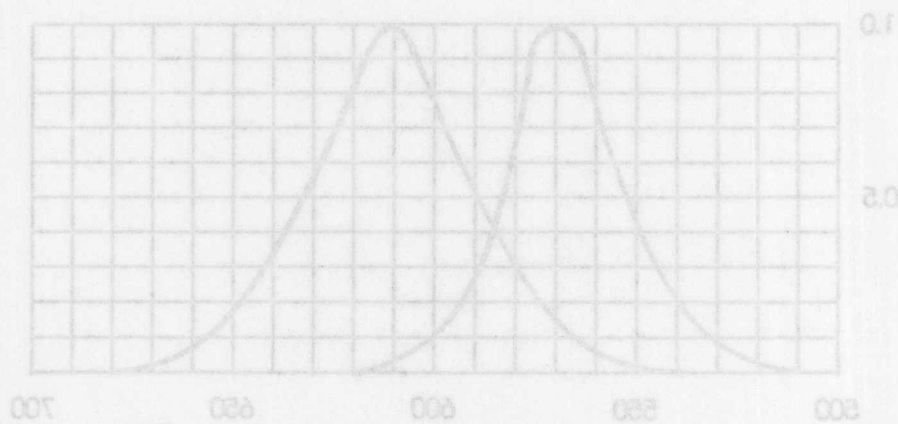
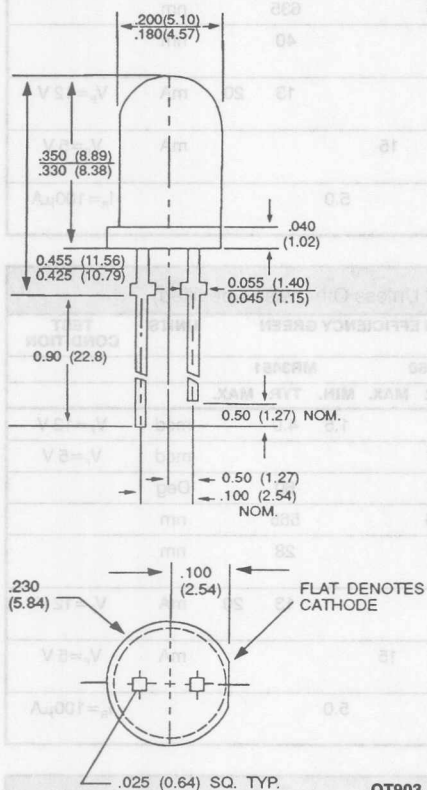


Fig. 6: Relative Intensity vs. Wavelength

RED MR3050/MR3051 TINTED
HIGH EFFICIENCY RED MR3750/MR3751 TINTED
YELLOW MR3350/MR3351 TINTED
HIGH EFFICIENCY GREEN MR3450/MR3451 TINTED

PACKAGE DIMENSIONS



DESCRIPTION

This group of T-1 3/4 size LED lamps contain integral resistors. Operation at 5 volts (MR3X50 Part Nos.) or 12 volts (MR3X51 Part Nos.) is possible without the use of external current limiting resistors. Color tinted, diffused epoxy packages are used for all the lamps in this group.

FEATURES

- Integral Current Limiting Resistor
(No external resistor required)
- TTL Compatible
- Operate with 5 Volt & 12 Volt Supplies
- All Colors - Red, HER, Yellow, Green
- Wide Viewing Angle
- Solid-State Reliability

NOTES:

1. ALL TOLERANCES, UNLESS OTHERWISE SPECIFIED:
.XXX ± 010
2. ALL DIMENSIONS IN INCHES (MILLIMETERS)

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR
MR3050	Red	Red Diffused
MR3051	Red	Red Diffused
MR3750	High Efficiency Red	Red Diffused
MR3751	High Efficiency Red	Red Diffused
MR3350	Yellow	Yellow Diffused
MR3351	Yellow	Yellow Diffused
MR3450	High Efficiency Green	Green Diffused
MR3451	High Efficiency Green	Green Diffused

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25°C Unless Otherwise Specified)

PARAMETER	SYMBOL	RED						HIGH EFFICIENCY RED						UNITS	TEST CONDITION
		MR3050			MR3051			MR3750			MR3751				
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
Luminous Intensity	I _v				1.0	2.0					1.5	4.0		mcd	V _F =12 V
Luminous Intensity	I _v	1.0	2.0					1.5	4.0					mcd	V _F =5 V
Total Viewing Angle	2θ _{1/2}		60			60			60			60		Deg	
Peak Wavelength	λ _p		655			655			635			635		nm	
Spectral Line Halfwidth	Δ λ _{1/2}		24			24			40			40		nm	
Forward Current 12V Devices	I _F										13	20		mA	V _F =12 V
Forward Current 5V Devices	I _F		13	20		13	20		10	15				mA	V _F =5 V
Reverse Breakdown Voltage	V _R	5.0			5.0			5.0			5.0				I _R =100μA

ELECTRO-OPTICAL CHARACTERISTICS (TA = 25°C Unless Otherwise Specified)

PARAMETER	SYMBOL	YELLOW						HIGH EFFICIENCY GREEN						UNITS	TEST CONDITION
		MR3350			MR3351			MR3450			MR3451				
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.		
Luminous Intensity	I _v				1.5	4.0						1.5	4.0	mcd	V _F =12 V
Luminous Intensity	I _v	1.5	4.0					1.5	4.0					mcd	V _F =5 V
Total Viewing Angle	2θ _{1/2}		60			60			60			60		Deg	
Peak Wavelength	λ _p		583			583			565			565		nm	
Spectral Line Halfwidth	Δ λ _{1/2}		36			36			28			28		nm	
Forward Current 12V Devices	I _F				13	20						13	20	mA	V _F =12 V
Forward Current 5V Devices	I _F		10	15				12	15					mA	V _F =5 V
Reverse Breakdown Voltage	V _R	5.0			5.0			5.0			5.0				I _R =100μA

ABSOLUTE MAXIMUM RATINGS (TA = 25°C Unless Otherwise Specified)

	RED/HER/YELLOW 5 VOLT LAMPS	RED/HER/YELLOW 12 VOLT LAMPS	GREEN 5 VOLT LAMPS	GREEN 12 VOLT LAMPS
DC Forward Voltage (T _A = 25°C)	7.5 Volts	15 Volts	7.5 Volts	15 Volts
Reverse Voltage (I _R = 100 μA)	5 Volts	5 Volts	5 Volts	5 Volts
Operating Temperature Range	-40°C to +85°C	-40°C to +85°C	-20°C to +85°C	-20°C to +85°C
Storage Temperature Range	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Lead Soldering Temperature	260°C for 5 seconds			

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

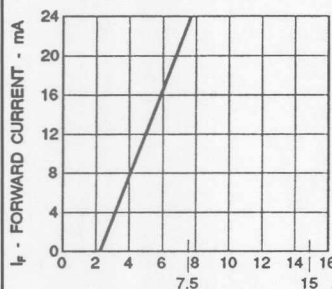


Fig. 1. Forward Current vs. Applied Forward Voltage 5 Volt Devices

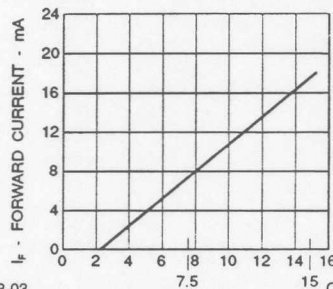


Fig. 2. Forward Current vs. Applied Forward Voltage 12 Volt Devices

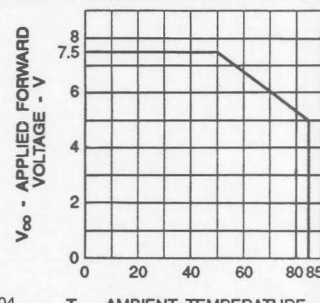


Fig. 3. Maximum Allowed Applied Forward Voltage vs. Ambient Temperature
 $R\theta_{JA} = 175^\circ\text{C/W}$ 5 Volt Devices

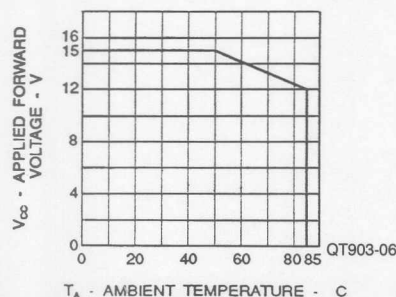


Fig. 4. Maximum Allowed Applied Forward Voltage vs. Ambient Temperature
 $R\theta_{JA} = 175^\circ\text{C/W}$ 12 Volt Devices

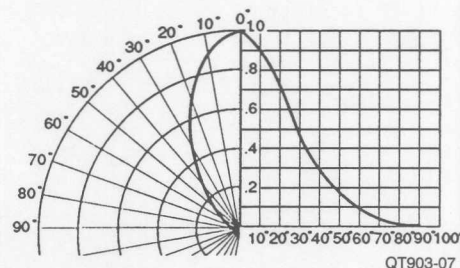


Fig. 5. Relative Luminous Intensity vs. Angular Displacement for T-1 3/4 Package

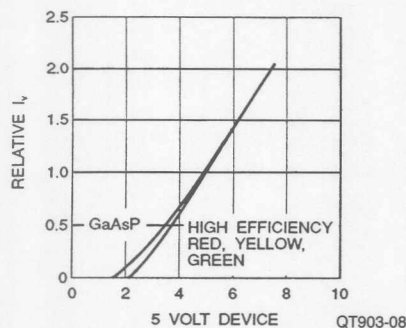


Fig. 6. Relative Luminous Intensity vs. Applied Forward Voltage 5 Volt Devices

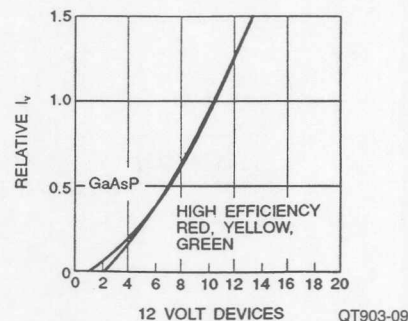
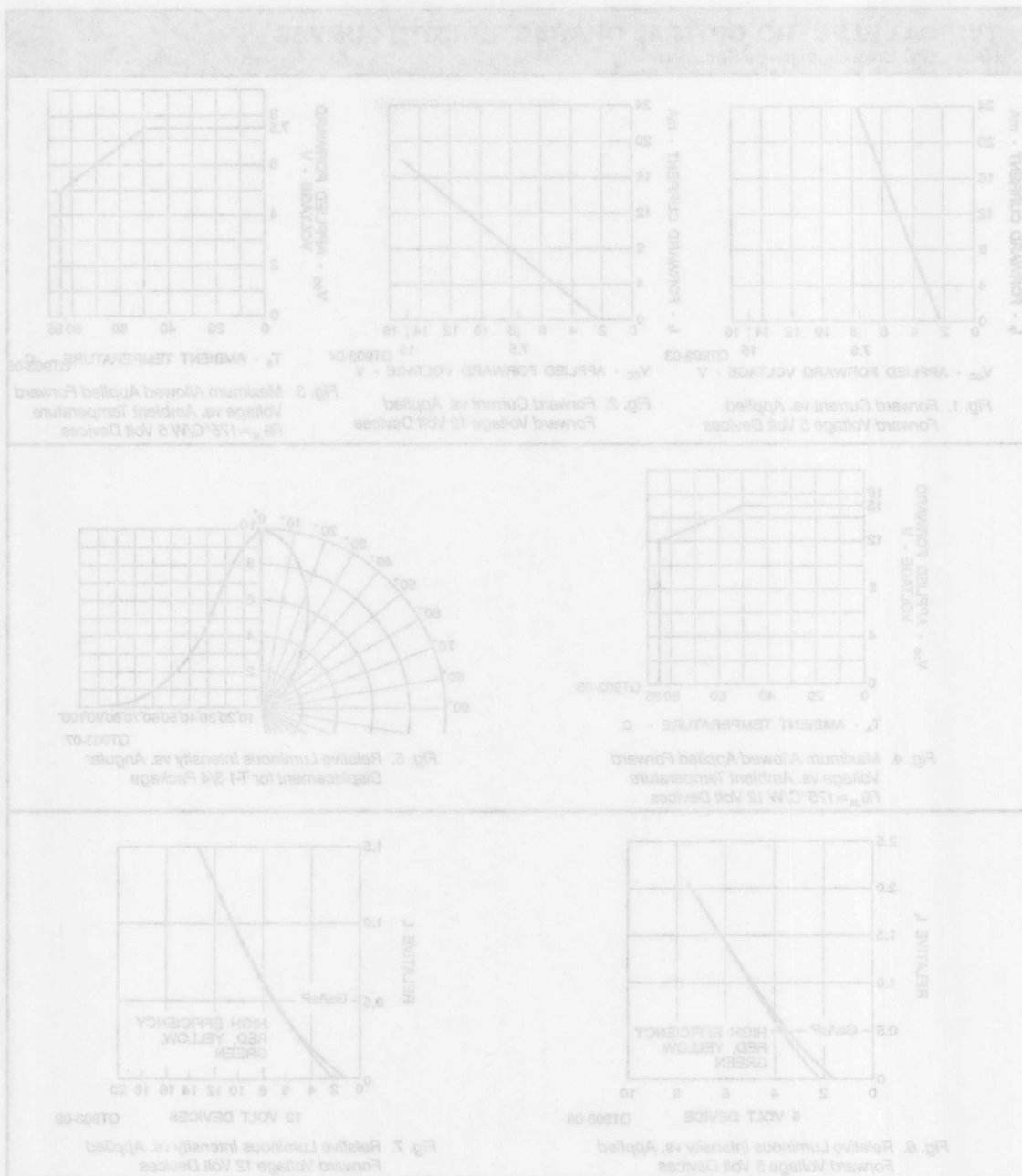


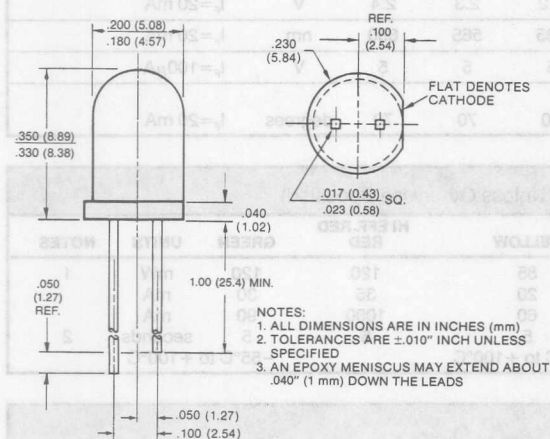
Fig. 7. Relative Luminous Intensity vs. Applied Forward Voltage 12 Volt Devices



**HIGH EFFICIENCY RED (ORANGE) MV6151
YELLOW MV6351**

**HIGH EFFICIENCY GREEN MV6451
AlGaAs RED MV6951**

PACKAGE DIMENSIONS



DESCRIPTION

This White Diffused family of T-1 $\frac{3}{4}$ lamps gives maximum ON/OFF contrast in high ambient lighting levels. The family features Orange, AlGaAs Red (Dark Red), Yellow and High Efficiency Green as well as High Efficiency Red, which here is Orange. The family exhibits wide viewing angle intended for direct view.

FEATURES

- Excellent ON/OFF contrast
- Pale tint, diffused
- AlGaAs Red plus 3 bright colors: High Efficiency Red/Orange, Yellow and Green
- Alternative for popular MV6X53 family
- Snap-in grommet MP52 available as separate order item

6

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	APPLICATION
MV6151	High Efficiency Red	Pale Orange Diffused	Orange Diffused	Direct View
MV6351	Yellow	Pale Yellow Diffused	Yellow Diffused	Direct View
MV6451	High Efficiency Green	Pale Green Diffused	Green Diffused	Direct View
MV6951	AlGaAs Red	Pale Pink Diffused	Red Diffused	Direct View

MV6151 MV6351 MV6451 MV6951

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER		SYMBOL	MV6151	MV6351	MV6451	MV6951	UNITS	TEST COND.	NOTES
Luminous Intensity	min.	I_v	3.0	3.0	3.0	3.0	mcd	$I_F = 20\text{ mA}$	
	typ.		12	12	12	12	mcd	$I_F = 20\text{ mA}$	
Forward voltage	max.	V_F	3.0	3.0	3.0	3.0	V	$I_F = 20\text{ mA}$	
	typ.		2.1	2.2	2.3	2.4	V	$I_F = 20\text{ mA}$	
Peak wavelength	typ.	λ_p	635	585	565	650	nm	$I_F = 20\text{ mA}$	
Reverse breakdown voltage	min.	V_{BR}	5	5	5	5	V	$I_F = 100\mu\text{A}$	
Total viewing angle between half luminous points	typ.	$2\theta_{1/2}$	70	70	70	70	degrees	$I_F = 20\text{ mA}$	

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	YELLOW	HI EFF. RED	RED	GREEN	UNITS	NOTES
Power dissipation	85	120	120	120	mW	1
Continuous forward current	20	35	30	30	mA	
Peak forward current ($1\mu\text{s}$, 0.3% DF)	60	1000	90	90	mA	
Lead soldering time at 260°C	5	5	5	5	seconds	2
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$			-55°C to $+100^\circ\text{C}$		

NOTES

- Derate linearly from 25°C (MV6451 from 50°C) at $1.6\text{ mW}/^\circ\text{C}$.
- From a point minimum $1/16$ inch (1.6 mm) from the bottom of the lamp.

TYPE	SOURCE COLOR	LENS COLOR	LENS EFFECT	APPLICATION
MV6151	High Efficiency Red	Pale Orange Diffused	Orange Diffused	Direct View
MV6351	Yellow	Pale Yellow Diffused	Yellow Diffused	Direct View
MV6451	High Efficiency Green	Pale Green Diffused	Green Diffused	Direct View
MV6951	AlGaAs Red	Pale Pink Diffused	Red Diffused	Direct View

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified)

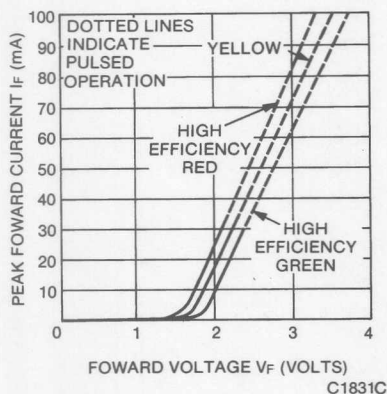


Fig. 1. Forward Current vs. Forward Voltage

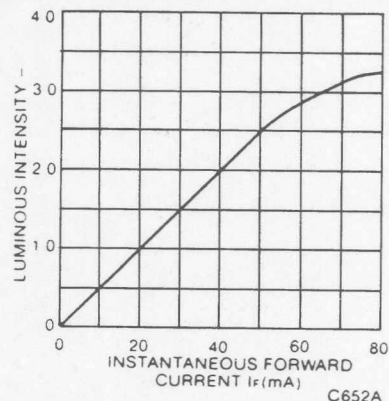


Fig. 2. Luminous Intensity vs. Forward Current

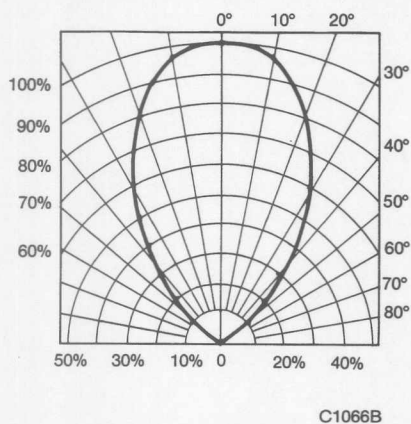


Fig. 3. Spatial Distribution

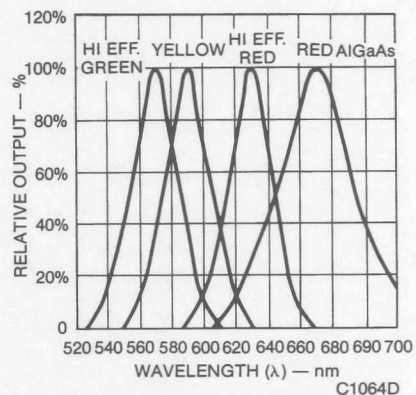


Fig. 4. Spectral Distribution

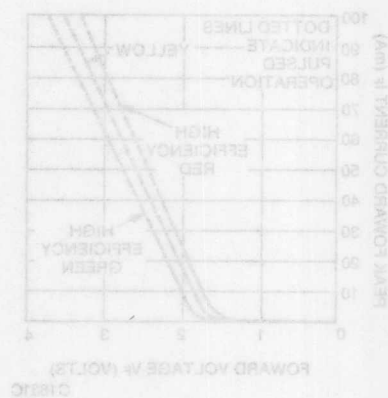


Fig. 1. Forward Current vs. Forward Voltage

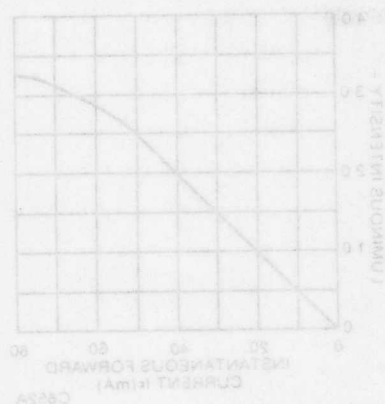


Fig. 2. Luminous Intensity vs. Forward Current

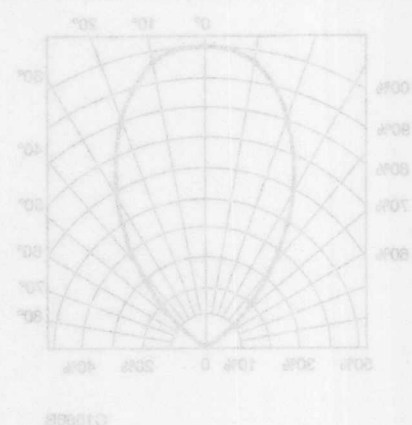


Fig. 3. Spatial Distribution

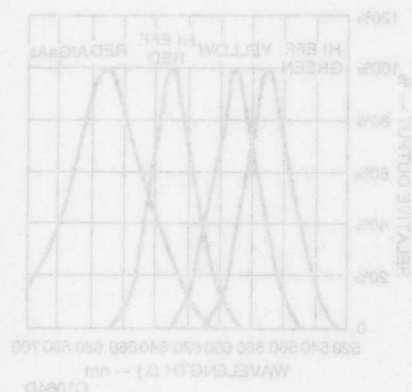
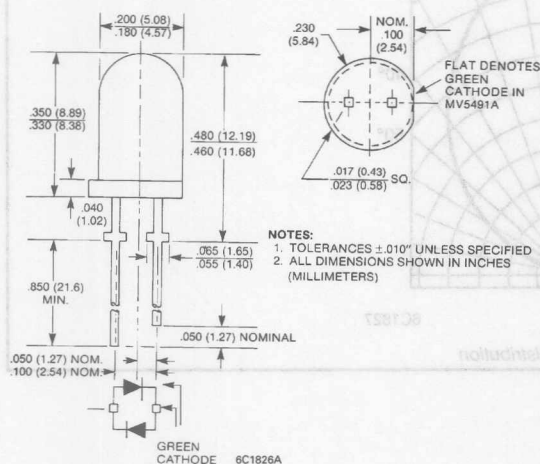


Fig. 4. Spectral Distribution

**HIGH EFFICIENCY GREEN/AlGaAs RED MV5491A
HIGH EFFICIENCY RED/AlGaAs RED MV5094A**

PACKAGE DIMENSIONS



DESCRIPTION

The Green/Red MV5491A and Red/Red MV5094A are superior drop-in replacements for Quality Technologies' bicolor Green/Red MV5491 or MV9475 and for bipolar Red/Red MV5094 or MV9775. The MV5491A is a White Diffused, very wide viewing angle, dual chip, 4-state lamp utilizing Deep Red AlGaAs and High Efficiency Green. AC-driven, the LED lamp appears Orange. The MV5094A is a Red Diffused, very wide viewing angle bipolar Red (AC) lamp featuring Red AlGaAs and High Efficiency Red chips.

FEATURES

- Excellent uniformity and visual appeal
- Very wide viewing angle for perfect direct view
- Increased reliability
- Radically improved die-off-center characteristics
- Same current for both colors for minimum component count
- Improved solder heat durability
- 4-state; Green, Red, Orange, OFF (MV5491A)
- 1" leads
- May be panel mounted—MP52 is separate order item

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER		SYMBOL	MV5491A	MV5094A	UNITS	TEST CONDITIONS
Luminous Intensity	min.	I_V	2.0	2.0	mcd	$I_F = 20\text{ mA}$
	typ.		6.0	6.0	mcd	$I_F = 20\text{ mA}$
Forward voltage	max.	V_F	3.0	3.0	V	$I_F = 20\text{ mA}$
	typ.		2.3	2.3	V	$I_F = 20\text{ mA}$
Dominant wavelength	typ.	λ_d	568/650	630/650	nm	$I_F = 20\text{ mA}$
Total viewing angle between half luminous intensity points	typ.	$2\theta_{1/2}$	100	75	degrees	$I_F = 20\text{ mA}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	RATING	UNITS	NOTES
Power dissipation	135	mW	1
Peak current	90	mA	
Average current	30	mA	2
Lead soldering time	5	seconds	
Lead soldering temperature	260°C		
Storage and operating temperatures	-55°C to +100°C		3

NOTES

1. Derate power linearly from 25°C at 1.8 mW/°C.
2. Derate power linearly from 50°C at 0.5 mA/°C.
3. To a point minimum 1/16 inch (1.6 mm) from the bottom of the lamp.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(T_A=25°C Unless Otherwise Specified)

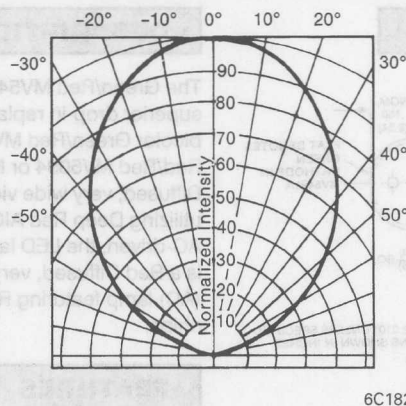


Fig. 1. Spatial Distribution

- May be panel mounted—MP52 is separate order item
- 1" leads
- 4-state: Green, Red, Orange, OFF (MV5491A)
- Improved solder heat durability
- count
- Same current for both colors for minimum component
- Radically improved die-off-center characteristics
- Increased reliability
- Very wide viewing angle for perfect direct view

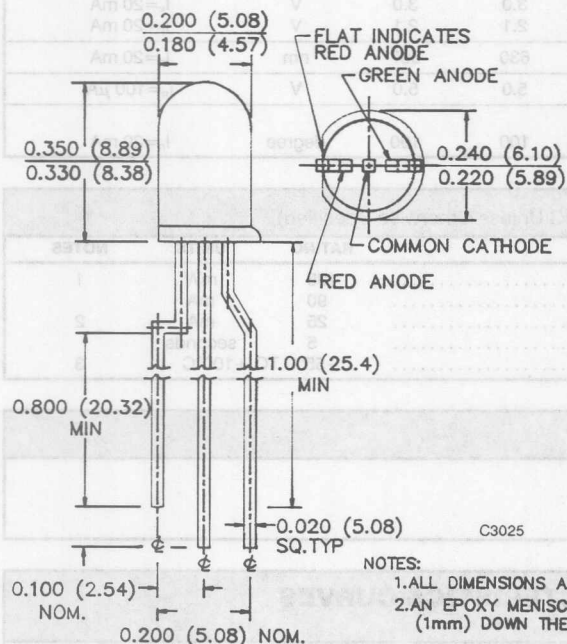
PARAMETER	SYMBOL	UNIT	MV5491A	MV5491A	TEST CONDITIONS
Luminous intensity	I _v	cd	2.0	2.0	I _f =50 mA
Forward voltage	V _f	V	2.0	2.0	I _f =50 mA
Dominant wavelength	λ _d	nm	630-650	630-650	I _f =50 mA
Total viewing angle between half luminous intensity points	2θ _{1/2}	degrees	75	100	I _f =50 mA

PARAMETER	UNIT	TEST CONDITIONS
Power dissipation	mW	100
Peak current	mA	50
Average current	mA	30
Lead soldering time	seconds	5
Lead soldering temperature	°C	260
Storage and operating temperatures	°C	-55 to +100

1. Device power dissipation from 25°C at 1.8 mW/C.
2. Device power dissipation from 50°C at 0.5 mW/C.
3. To a point minimum 1/8 inch (1.6 mm) from the bottom of the lamp.

HIGH EFFICIENCY GREEN/HIGH EFFICIENCY RED MV5437

PACKAGE DIMENSIONS



DESCRIPTION

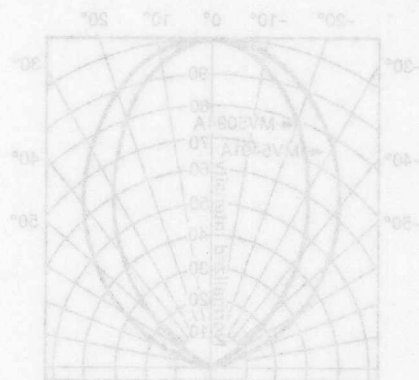
The MV5437 T-1 1/4 lamp is a three leaded bicolor light source with a central common cathode lead.

FEATURES

- Excellent uniformity and visual appeal
- Very wide viewing angle for perfect direct view
- Increased reliability
- Radically improved die-off-center characteristics
- Improved solder heat durability
- 4-state; Green, Red, Amber, OFF.
- TTL compatible

NOTES:

1. ALL DIMENSIONS ARE IN INCHES (mm)
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 0.040" (1mm) DOWN THE LEADS.



ELECTRO-OPTICAL CHARACTERISTICS (25°C Unless Otherwise Specified)

PARAMETER		SYMBOL	RED	GREEN	UNITS	TEST CONDITIONS
Luminous intensity	min.	I_V	2.0	2.0	mcd	$I_F=20$ mA
	typ.		6.0	6.0	mcd	$I_F=20$ mA
Forward voltage	max.	V_F	3.0	3.0	V	$I_F=20$ mA
	typ.		2.1	2.1	V	$I_F=20$ mA
Dominant wavelength	typ.	λ_d	630	567	nm	$I_F=20$ mA
Reverse breakdown	min.	V_{BR}	5.0	5.0	V	$I_R=100$ μ A
Total viewing angle between half Luminous intensity points		20 $\frac{1}{2}$	100	100	degree	$I_F=20$ mA

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

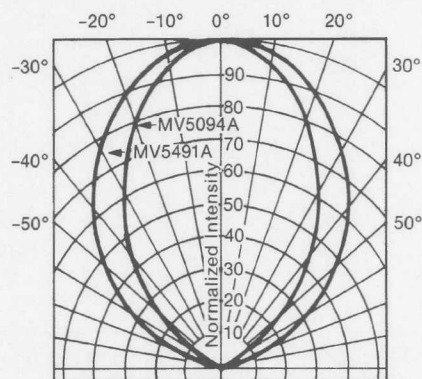
PARAMETERS	RATING	UNITS	NOTES
Power dissipation	135	mW	1
Peak current	90	mA	
Average current	25	mA	2
Lead soldering time	5	seconds	
Storage and operating temperatures	-55°C TO +100°C		3

NOTES

1. Derate power linearly from 25°C at 1.8 mW/°C
2. Derate current linearly from 50°C at 0.5 mA/°C
3. To a point minimum 1/16 inch (1.6 mm) from the bottom lamp.

TYPICAL ELECTRO-OPTICAL CHARACTERISTICS CURVES

($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

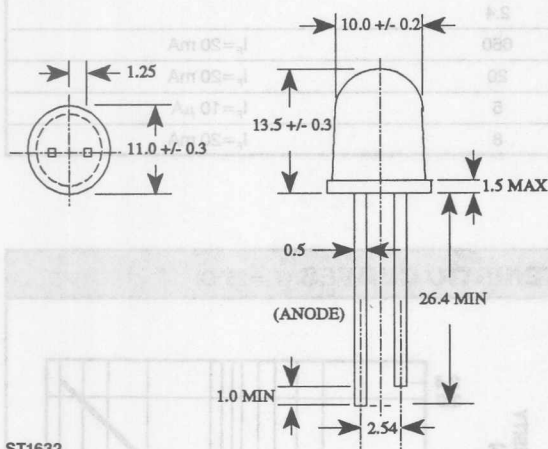


6C1827

Fig. 1. Spatial Distribution

**SUPER RED MV9100 CLEAR
SUPER RED MV9101 CLEAR
SUPER RED MV9102 CLEAR**

PACKAGE DIMENSIONS



ST1632

NOTES:

1. ALL DIMENSIONS ARE IN MM.
2. LEAD SPACING IS MEASURED WHERE THE LEADS EMERGE FROM THE PACKAGE.
3. PROTRUDED RESIN UNDER THE FLANGE IS 1.5 mm (0.059") MAX.

DESCRIPTION

These 10 mm super bright LEDs have a narrow 8° viewing angle for concentrated light output. The MV9100/1/2 are made with GaAlAs LEDs on a GaAs substrate. They are all encapsulated in an epoxy package and have water clear lenses.

FEATURES

- Outstanding material efficiency.
- Low drive current.
- Solid state reliability.
- Super high brightness suitable for outdoor applications.
- Standard 1 mil. lead spacing.

ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

DC forward current (I_f)	40 mA
Operating temperature range	-40°C to $+85^\circ\text{C}$
Storage temperature range	-40°C to $+100^\circ\text{C}$
Lead soldering time (at $\frac{1}{16}$ inch from the bottom of lamp)	5 seconds @ 260°C
Peak forward current (I_p) (at $f = 1.0$ KHz, Duty factor = $1/10$)	200 mA
Power dissipation (P_d)	110 mW
Recommended operating current (I_f Rec)	20 mA

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

PART NUMBER	MV9100	MV9101	MV9102	TEST CONDITIONS
Luminous intensity (mcd)				$I_F = 20\text{ mA}$
minimum	600	1000	1600	
typical	940	1500	2400	
Forward voltage (V_F)				$I_F = 20\text{ mA}$
minimum		1.5		
typical		1.7		
maximum		2.4		
Peak wavelength (nm)		660		$I_F = 20\text{ mA}$
Spectral line half width (nm)		20		$I_F = 20\text{ mA}$
Reverse breakdown voltage (V_R)		5		$I_F = 10\text{ }\mu\text{A}$
Viewing angle ($^\circ$)		8		$I_F = 20\text{ mA}$

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

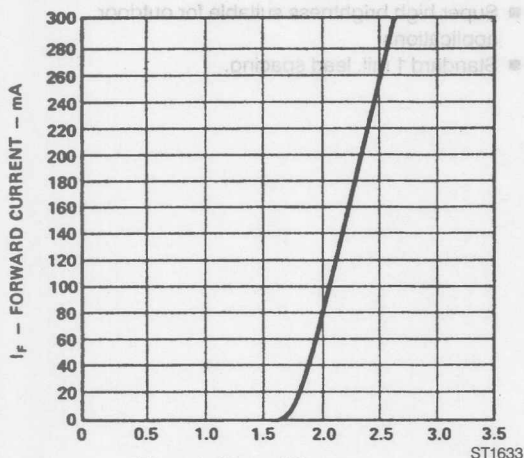


Figure 1. Forward Current vs. Forward Voltage

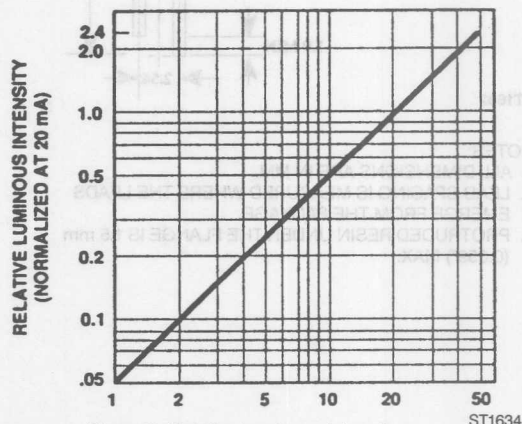


Figure 2. Relative Luminous Intensity vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES ($T_A = 25^\circ\text{C}$)

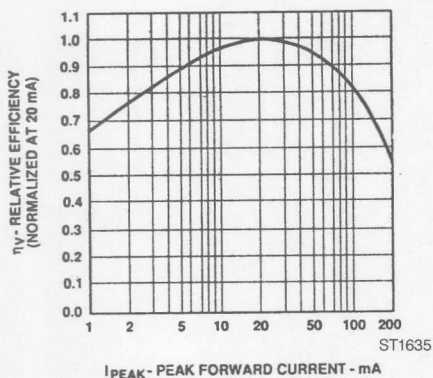


Figure 3. Relative Efficiency vs. Peak Forward Current

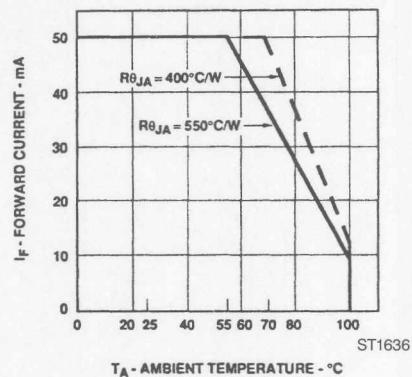


Figure 4. Maximum Forward DC Current vs. Ambient Temperature
Derating based on $T_J \text{ MAX} = 110^\circ$.

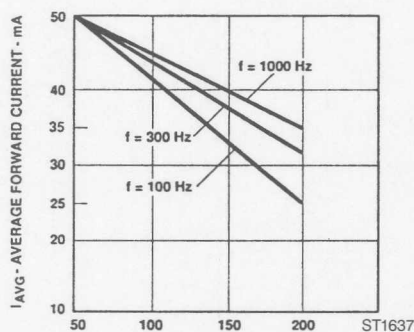


Figure 5. Maximum Average Current vs. Forward Current

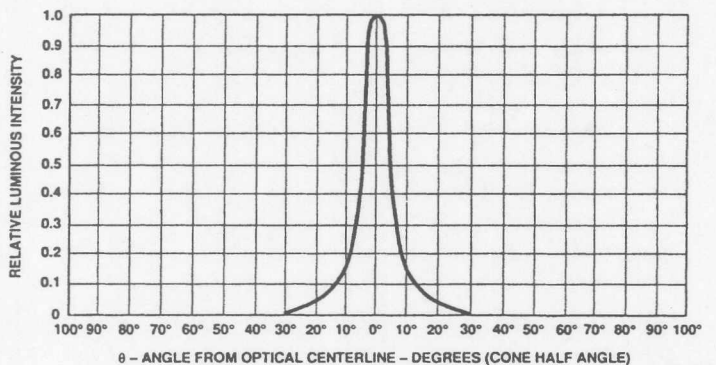


Figure 6. Relative Luminous Intensity vs. Angular Displacement

TYPICAL LED OPTICAL CHARACTERISTICS CURVES

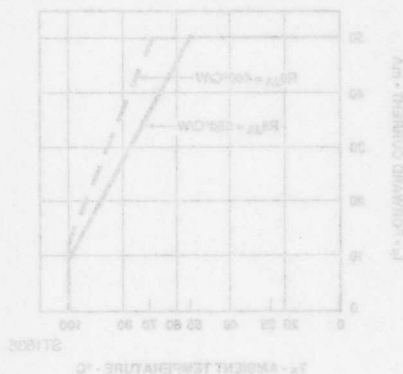


Figure 4: Maximum Forward DC Current vs Ambient Temperature
Derating based on $T_{MAX}=110^\circ\text{C}$

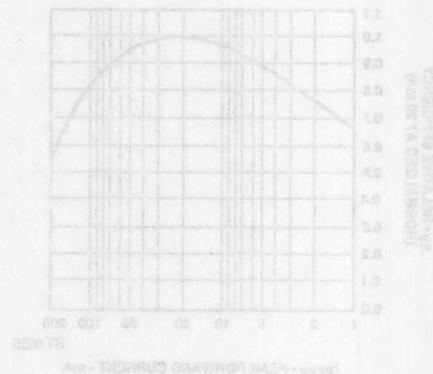


Figure 5: Relative Efficiency vs Peak Forward Current

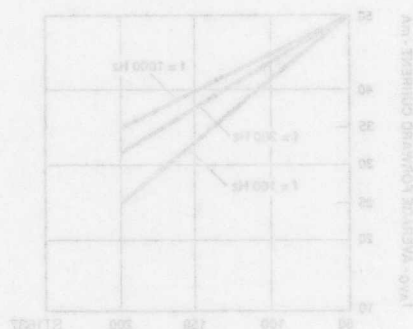


Figure 6: Minimum Average Current vs Forward Current

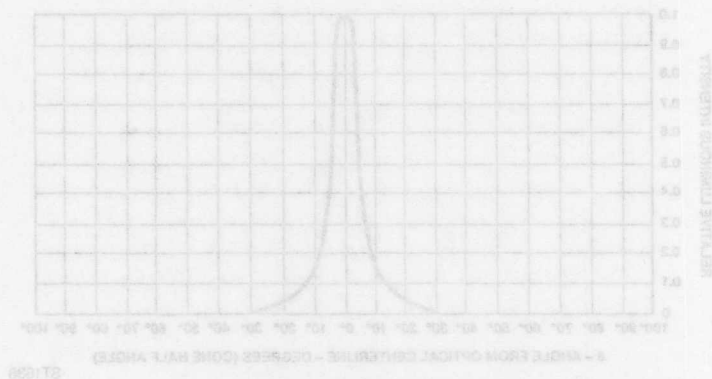
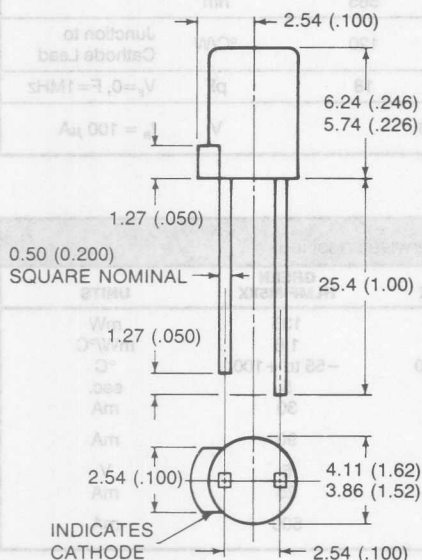


Figure 7: Relative Luminous Intensity vs Angular Displacement

RED (HIGH EFFICIENCY) HLMP-M200/M201 HLMP-M250/M251
YELLOW HLMP-M300/M301 HLMP-M350/M351
GREEN HLMP-M500/M501 HLMP-M550/M551

PACKAGE DIMENSIONS



DIMENSIONS IN MILLIMETERS (INCHES)

C3001

DESCRIPTION

Bright colors and a wide viewing angle are the outstanding features of the new 4 mm flat top lamps. The cylindrical shape and flat emitting surface make these lamps particularly well suited for applications requiring high light output in minimal space.

FEATURES

- Replaces Hewlett-Packard devices
- Wide viewing angle
- Excellent for backlighting small areas
- Solid state reliability
- Compact, rugged, lightweight
- Choice of tinted nondiffused and tinted diffused package

PHYSICAL CHARACTERISTICS

PART NUMBER	DESCRIPTION	I _v (mcd)		TEST CONDITION (mA)	TOTAL VIEWING ANGLE
		MIN	TYPE		
HLMP-M200	Red, Diffused	3.4	5.0	20	135
HLMP-M201	Red, Diffused, High Brightness	5.4	7.0	20	
HLMP-M250	Red, Nondiffused	3.4	5.0	10	80
HLMP-M251	Red, Nondiffused, High Brightness	5.4	7.0	10	
HLMP-M300	Yellow, Diffused	3.6	5.0	20	135
HLMP-M301	Yellow, Diffused, High Brightness	5.7	7.0	20	
HLMP-M350	Yellow, Nondiffused	3.6	5.0	10	80
HLMP-M351	Yellow, Nondiffused, High Brightness	5.7	7.0	10	
HLMP-M500	Green, Diffused	4.2	7.0	20	135
HLMP-M501	Green, Diffused, High Brightness	6.7	10.0	20	
HLMP-M550	Green, Nondiffused	4.2	10.0	10	80
HLMP-M551	Green, Nondiffused, High Brightness	6.7	16.0	10	

ELECTRO-OPTICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

PARAMETERS	H.E. RED HLMP-M2XX			YELLOW HLMP-M3XX			GREEN HLMP-M5XX			UNITS	TEST CONDITIONS
	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
Forward Voltage		2.2	3.0		2.2	3.0		2.3	3.0	V	$I_F = 20\text{ mA}$
Speed of Response		90			90			500		ns	
Peak Wavelength		635			585			565		nm	
Thermal Resistance		120			120			120		$^\circ\text{C/W}$	Junction to Cathode Lead
Capacitance		20			15			18		pF	$V_F = 0, F = 1\text{ MHz}$
Reverse Breakdown Voltage	5.0			5.0			5.0			V	$I_R = 100\text{ }\mu\text{A}$

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ unless otherwise specified)

PARAMETER	H.E. RED HLMP-M2XX	YELLOW HLMP-M3XX	GREEN HLMP-M5XX	UNITS
Power dissipation	135	120	135	mW
Derate linearly from 25°C	1.6	1.6	1.6	$\text{mW}/^\circ\text{C}$
Storage & operating temperature	-55 to +100	-55 to +100	-55 to +100	$^\circ\text{C}$
Lead soldering time at 260°C	5	5	5	sec.
Continuous forward current	35	20	30	mA
Peak forward current $1\text{ }\mu\text{ sec. pulse}$	90	60	90	mA
0.3% duty cycle				
Reverse voltage ($I_R = 100\text{ }\mu\text{A}$)	5	5	5	V
Average forward current	25	20	25	mA
Transient forward current ($10\text{ }\mu\text{ sec pulse}$)	500	500	500	mA

HLMP-M2XX HLMP-M3XX HLMP-M5XX

PART NUMBER	DESCRIPTION	MIN TYPE	TEST CONDITION (mA)	VIEWING ANGLE
HLMP-M200	Red, Diffused	3.4	20	135
HLMP-M201	Red, Diffused, High Brightness	2.4	20	
HLMP-M250	Red, NonDiffused	3.4	10	80
HLMP-M251	Red, NonDiffused, High Brightness	2.4	10	
HLMP-M300	Yellow, Diffused	3.0	20	135
HLMP-M301	Yellow, Diffused, High Brightness	2.7	20	
HLMP-M350	Yellow, NonDiffused	3.0	10	80
HLMP-M351	Yellow, NonDiffused, High Brightness	2.7	10	
HLMP-M500	Green, Diffused	4.2	20	135
HLMP-M501	Green, Diffused, High Brightness	3.7	20	
HLMP-M550	Green, NonDiffused	4.2	10	80
HLMP-M551	Green, NonDiffused, High Brightness	3.7	10	

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

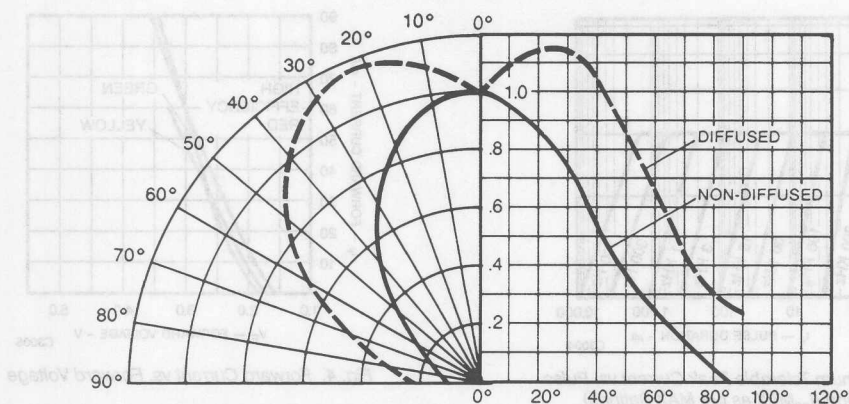


Fig. 1. Relative Luminous Intensity vs. Angular Displacement

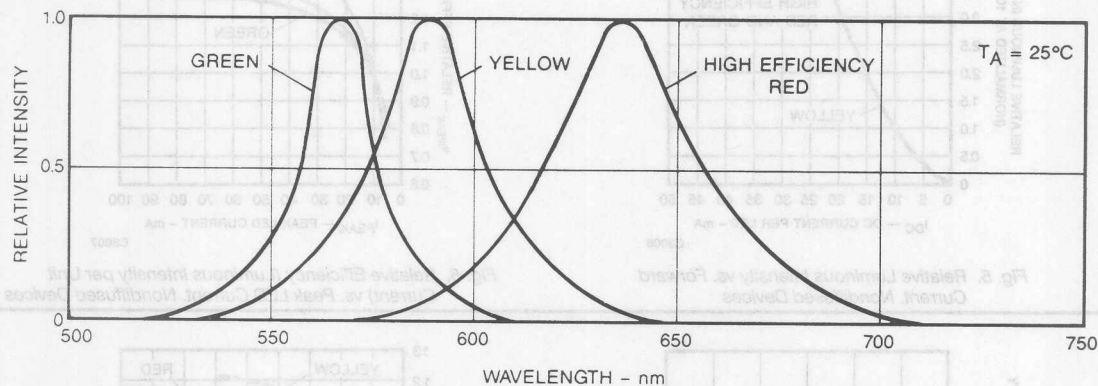


Fig. 2. Relative Intensity vs. Wavelength

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES (Cont'd)

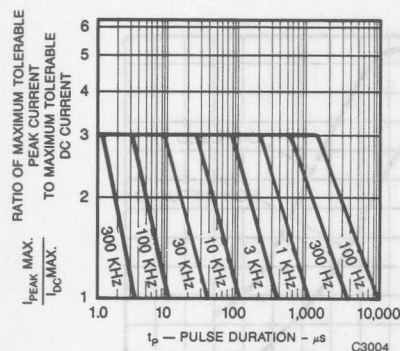


Fig. 3. Maximum Tolerable Peak Current vs. Pulse Duration ($I_{DC}MAX$ as per MAX Ratings)

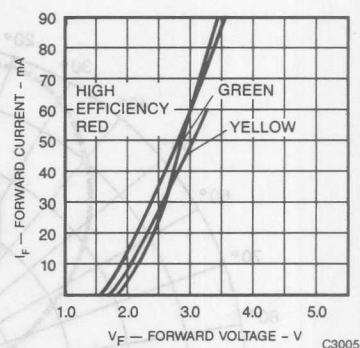


Fig. 4. Forward Current vs. Forward Voltage

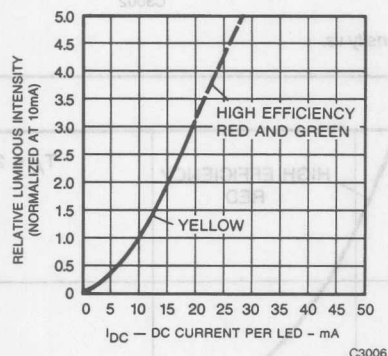


Fig. 5. Relative Luminous Intensity vs. Forward Current. Nondiffused Devices

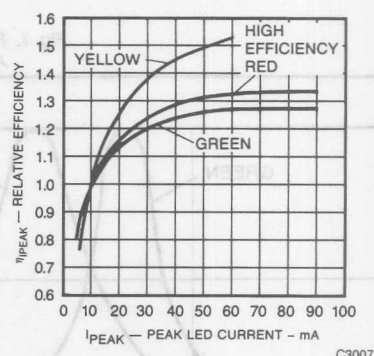


Fig. 6. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current. Nondiffused Devices

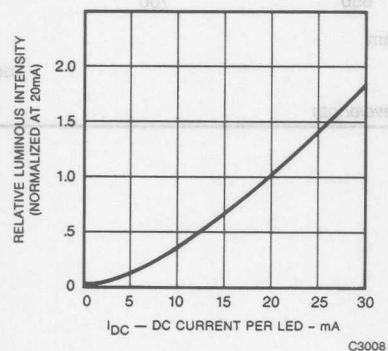


Fig. 7. Relative Luminous Intensity vs. Forward Current. Nondiffused Devices

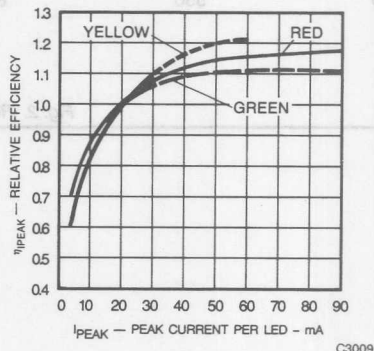
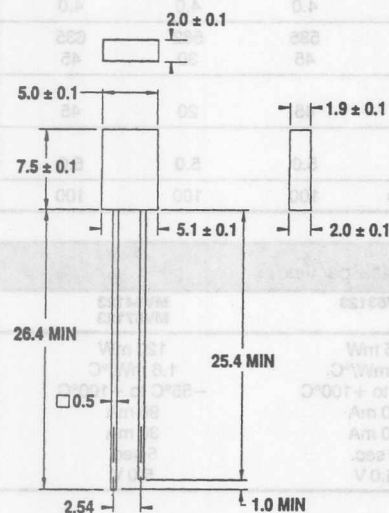


Fig. 8. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current. Nondiffused Devices

YELLOW MV53123
HIGH EFFICIENCY GREEN MV54123
HIGH EFFICIENCY RED MV57123

PACKAGE DIMENSIONS



C1667A

NOTES:

1. ALL DIMENSIONS ARE IN INCHES (MM)
2. TOLERANCES ARE ± 0.10 " INCHES UNLESS SPECIFIED.
3. AN EPOXY MENISCUS MAY EXTEND ABOUT .40" (1MM) DOWN THE LEADS. THE BASE OF THE PACKAGE IS NOT FLAT.

DESCRIPTION

These rectangular LED lamps provide a lighted surface area 2×5 mm. The High Efficiency Red and Yellow solid state lamps contain a gallium arsenide phosphide on gallium phosphide light emitting diode. The High Efficiency Green Lamps utilize an improved gallium phosphide light emitting diode.

FEATURES

- 2×5 mm lighted area
- High brightness—typically 4 mcd at 20 mA
- Solid state reliability
- Compact, rugged, lightweight

APPLICATIONS

- Legend backlighting
- Illuminated pushbutton
- Panel indicator
- Bargraph meter

ELECTRO-OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	TEST COND.	UNITS	MV53123	MV54123	MV57123
Forward voltage (V_F)					
typ.	$I_F=20\text{ mA}$	V	2.1	2.2	2.0
max.	$I_F=20\text{ mA}$	V	3.0	3.0	3.0
Luminous Intensity					
min.	$I_F=20\text{ mA}$	mcd	1.0	1.0	1.0
typ.	$I_F=20\text{ mA}$	mcd	4.0	4.0	4.0
Peak wavelength		mcd	585	562	635
half width	$I_F=20\text{ mA}$	nm	45	30	45
Capacitance					
typ.	$V=0, f=1\text{ MHz}$	pF	45	20	45
Reverse voltage (V_R)					
min.	$I_R=100\text{ }\mu\text{A}$	V	5.0	5.0	5.0
Viewing angle (total)		degrees	100	100	100

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

	MV53123	MV54123 MV57123
Power dissipation	85 mW	120 mW
Derate linearly from 50°C	$1.6\text{ mW}/^\circ\text{C}$	$1.6\text{ mW}/^\circ\text{C}$
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$	-55°C to $+100^\circ\text{C}$
Peak forward current (1 μsec pulse width 300 pps)	60 mA	90 mA
Forward current	20 mA	30 mA
Lead soldering time at 260°C (See Note 1)	5 sec.	5 sec.
Reverse voltage	5.0 V	5.0 V

NOTES:
1. ALL DIMENSIONS ARE IN INCHES (MM).
2. TOLERANCES ARE ± 0.01 INCHES UNLESS SPECIFIED.
3. AN EPOXY MENISCUS MAY EXTEND ABOUT ± 0.01 (MM) DOWN THE LEADS. THE BASE OF THE PACKAGE IS NOT FLAT.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature)

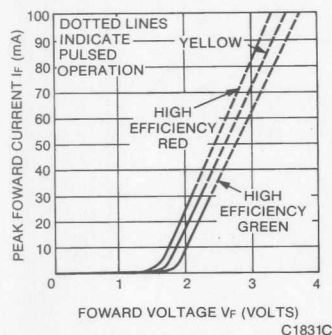


Fig. 1. Forward Current vs. Forward Voltage

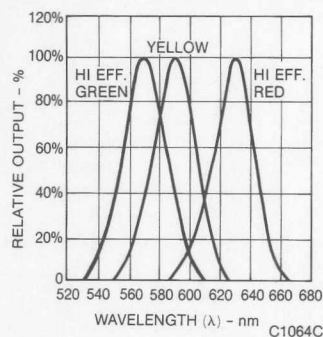


Fig. 2. Spectral Distribution

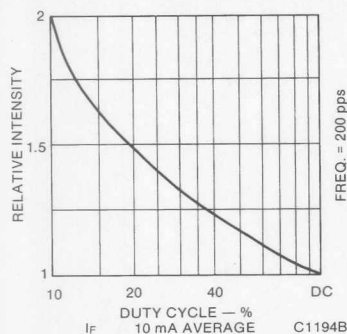


Fig. 3. Luminous Intensity vs. Duty Cycle

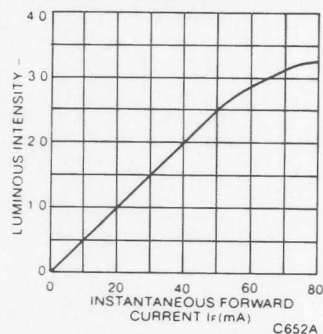


Fig. 4. Luminous Intensity vs. Forward Current

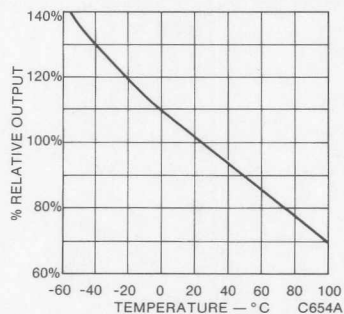


Fig. 5. Output vs. Temperature

NOTES

1. The leads of the device immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with dwell time of 5 seconds.

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
25°C Case All Temperatures

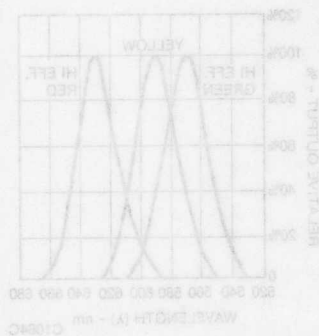


Fig. 2. Spectral Distribution

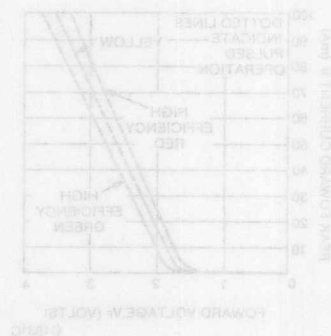


Fig. 1. Forward Current vs. Forward Voltage

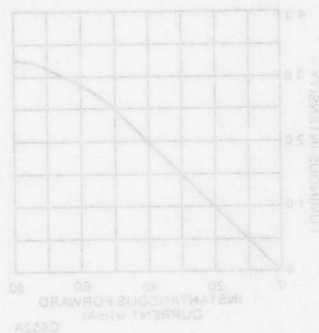


Fig. 4. Luminous Intensity vs. Forward Current

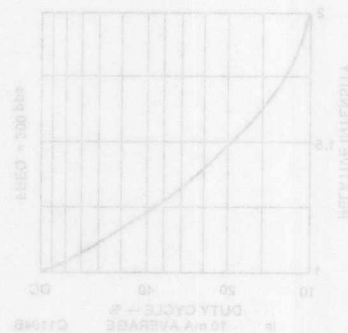


Fig. 3. Luminous Intensity vs. Duty Cycle

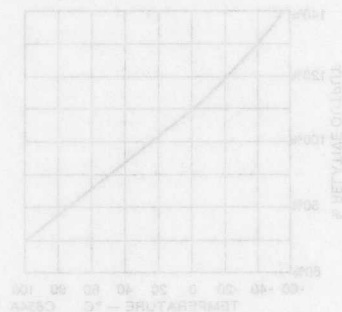


Fig. 5. Output vs. Temperature

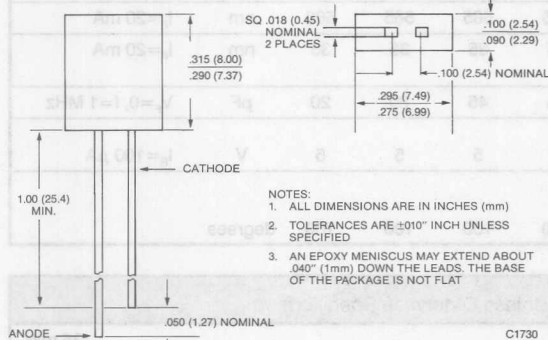
NOTES

1. The leads of the device immersed in molten solder, heated to a temperature of 260°C, to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-125, with dwell time of 2 seconds.

RECTANGULAR SOLID STATE LAMPS

HIGH EFFICIENCY RED HLMP-0300/1
YELLOW HLMP-0400/1
HIGH EFFICIENCY GREEN HLMP-0503/4

PACKAGE DIMENSIONS



DESCRIPTION

The HLMP-0X0X Series of rectangular lamps are direct replacements for Hewlett-Packard's series with the same part numbering. The series is similar to MV5X123 except for the larger lens size. Like the MV5X123, the HLMP-0X0X is stackable. The lamps are tinted diffused and intended for direct view.

FEATURES

- 3 High Efficiency colors
- Rectangular light area
- Inexpensive panel indicators

PHYSICAL CHARACTERISTICS

DEVICE	SOURCE COLOR	LENS COLOR	LENS EFFECT	I _v MIN. AT 20 mA
HLMP-0300	High Efficiency Red	Red Diffused	Very Wide Beam	1.0
HLMP-0301	High Efficiency Red	Red Diffused	Very Wide Beam	2.5
HLMP-0400	Yellow	Yellow Diffused	Very Wide Beam	1.5
HLMP-0401	Yellow	Yellow Diffused	Very Wide Beam	3.0
HLMP-0503	High Efficiency Green	Green Diffused	Very Wide Beam	1.5
HLMP-0504	High Efficiency Green	Green Diffused	Very Wide Beam	3.0

6

HLMP-0300/1 HLMP-0400/1 HLMP-0503/4

ELECTRO-OPTICAL CHARACTERISTICS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

PARAMETER	SYMBOL	HLMP-							UNITS	TEST CONDITIONS
		HI. EFF. RED		YELLOW		HI. EFF. GREEN				
		0300	0301	0400	0401	0503	0504			
Luminous Intensity	min.	I_v	1.0	2.5	1.5	3.0	1.5	2.5	mcd	$I_F=20\text{ mA}$
	typ.		2.5	5.0	2.5	5.0	3.0	5.0	mcd	$I_F=20\text{ mA}$
Forward voltage	max.	V_F	3.0	3.0	3.0	3.0	3.0	3.0	V	$I_F=20\text{ mA}$
	typ.		2.1	2.1	2.2	2.2	2.3	2.3	V	$I_F=20\text{ mA}$
Peak wavelength	typ.	λ_p	635	635	585	585	565	565	nm	$I_F=20\text{ mA}$
Spectral line half width	typ.	$\Delta\lambda/2$	45	45	35	35	35	35	nm	$I_F=20\text{ mA}$
Capacitance	typ.	C	45	45	45	45	20	20	pF	$V_F=0, f=1\text{ MHz}$
Reverse breakdown voltage	min.	BV_r	5	5	5	5	5	5	V	$I_R=100\text{ }\mu\text{A}$
Total viewing angle between half Luminous Intensity points	typ.	$2\theta_{1/2}$	100	100	100	100	100	100	degrees	

ABSOLUTE MAXIMUM RATINGS ($T_A=25^\circ\text{C}$ Unless Otherwise Specified)

Power dissipation at 25°C ambient (HLMP-040X=85 mA)	135 mW
Derate linearly from 25°C	1.6 mW/ $^\circ\text{C}$
Storage and operating temperatures	-55°C to $+100^\circ\text{C}$
Lead soldering time at 260°C (See Note 1)	5 sec.
Continuous forward current at 25°C (HLMP-040X=20 mA)	30 mA
Peak forward current (1 μsec pulse, 0.3% DC) (HLMP-040X=60 mA)	90 mA

DEVICE	SOURCE COLOR	LENS COLOR	LENS EFFECT	I_v (mcd) at 20 mA
HLMP-0300	High Efficiency Red	Red Diffused	Very Wide Beam	1.0
HLMP-0301	High Efficiency Red	Red Diffused	Very Wide Beam	2.5
HLMP-0400	Yellow	Yellow Diffused	Very Wide Beam	1.5
HLMP-0401	Yellow	Yellow Diffused	Very Wide Beam	3.0
HLMP-0503	High Efficiency Green	Green Diffused	Very Wide Beam	1.5
HLMP-0504	High Efficiency Green	Green Diffused	Very Wide Beam	3.0

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

($T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

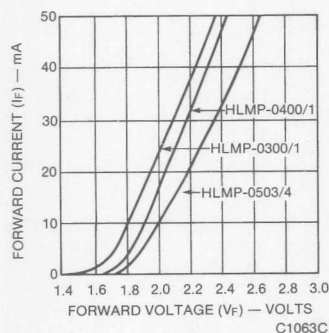


Fig. 1. Forward Current vs. Forward Voltage

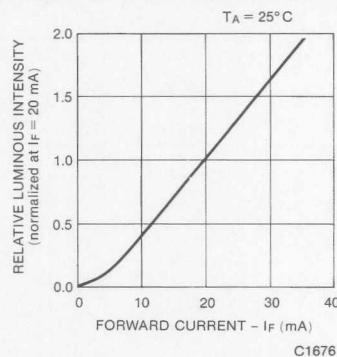


Fig. 2. Luminous Intensity vs. Forward Current

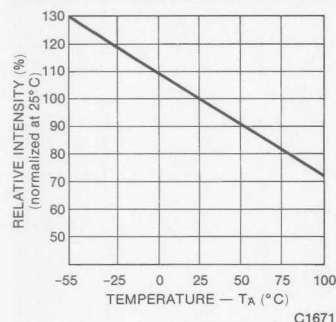


Fig. 3. Relative Luminous Intensity vs. Temperature

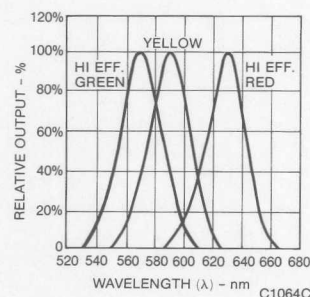


Fig. 4. Spectral Distribution

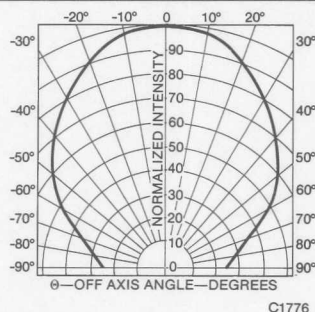


Fig. 5. Spatial Distribution

NOTES

1. The leads of the device immersed in molten solder, at 260°C , to a point 1/16 inch (1.6 mm) from the body of the device per MIL-S-750, with dwell time of 5 seconds.

TYPICAL ELECTRICAL AND OPTICAL CHARACTERISTICS

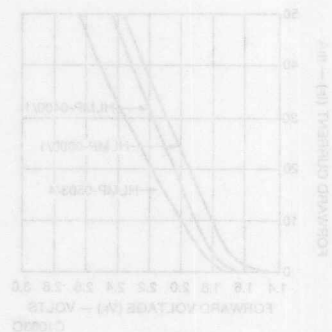


Fig. 1: Forward Current vs. Forward Voltage

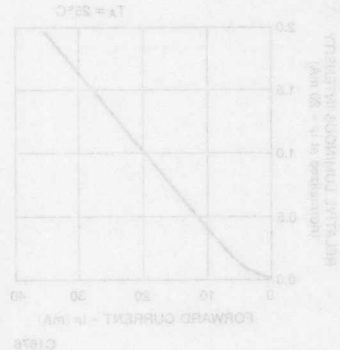


Fig. 2: Luminous Intensity vs. Forward Current

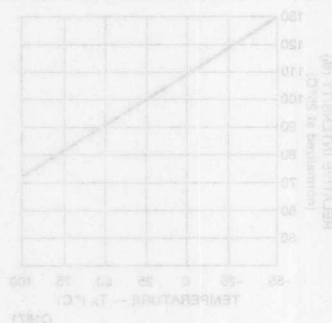


Fig. 3: Relative Luminous Intensity vs. Temperature

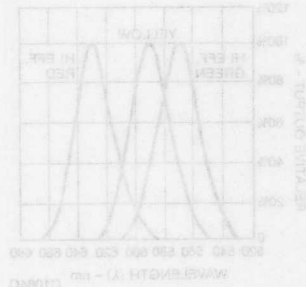


Fig. 4: Spectral Distribution

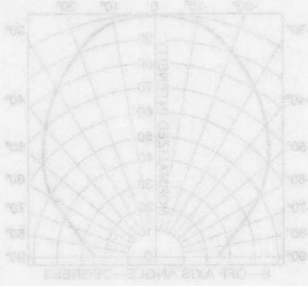


Fig. 5: Spatial Distribution

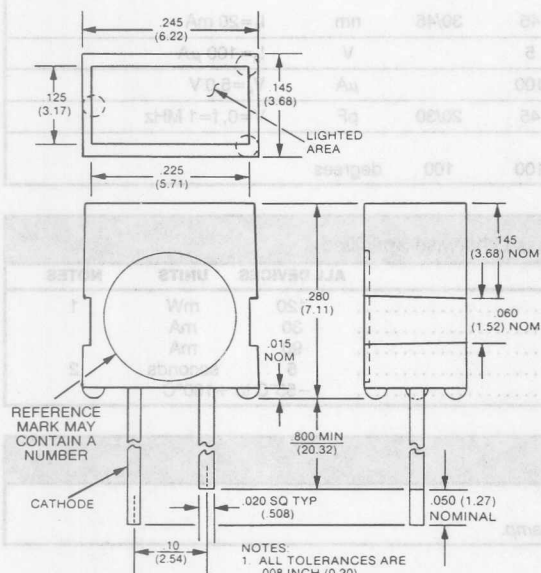
The lamp is the device mounted in a metal socket, at 25°C, to a point (1/8 inch (1.6 mm) from the body of the device per MIL-S-750, with dwell time of 5 seconds.

RECTANGULAR SOLID STATE LAMPS

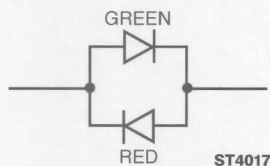
YELLOW	MV53124A
HIGH EFFICIENCY GREEN	MV54124A
HIGH EFFICIENCY RED	MV57124A
EFFICIENCY GREEN/AlGaAs RED	MV49124A

PACKAGE DIMENSIONS

DESCRIPTION



C1245B



FOR MV49124A

FEATURES

- Uniform illumination
- Increased typical brightness
- Tighter mechanical tolerances for base of design
- Stackable in X or Y direction without crosstalk
- .220" x .125" lighted area for direct view or legend backlighting
- Use Black MP65 two piece grommet for panel mounting
- Superior quality

APPLICATIONS

- Legend backlighting
- Panel indicator
- High quality bargraphs

PHYSICAL CHARACTERISTICS

TYPE	SOURCE COLOR	LENS EFFECT
MV53124A	Yellow	Yellow Diffused
MV53124A	High Eff. Green	Green Diffused
MV57124A	High Eff. Red	Red Diffused
MV49124A	High Eff. Green/AlGaAs Red	White Diffused

ELECTRO-OPTICAL CHARACTERISTICS (25°C Temperature Unless Otherwise Specified)

PARAMETER	SYMBOL	MV 53124A	MV 54124A	MV 57124A	MV 49124A	UNITS	TEST COND.	NOTES
Luminous Intensity	min. typ.	I_V	1.0 6.0	1.0 6.0	1.0 6.0	mcd mcd	$I_F=20$ mA $I_F=20$ mA	
Forward voltage	typ. max.	V_F	2.0 3.0	2.2 3.0	2.0 3.0	V V	$I_F=20$ mA $I_F=20$ mA	
Peak wavelength	λ_p		585	562	635	562/660	nm	$I_F=20$ mA
Spectral line half width			45	30	45	30/45	nm	$I_F=20$ mA
Reverse voltage	min.	V_{BR}	5	5	5	V		$I_R=100$ μ A
Reverse current	max.	I_R	100	100	100	μ A		$V_R=5.0$ V
Capacitance		C	45	20	45	20/30	pF	$V=0$, $f=1$ MHz
Viewing angle (total)		20½	100	100	100	100	degrees	

ABSOLUTE MAXIMUM RATINGS (25°C Unless Otherwise Specified)

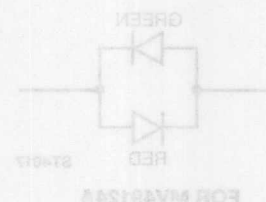
PARAMETER	ALL DEVICES	UNITS	NOTES
Power dissipation	120	mW	1
Continuous forward current	30	mA	
Peak forward current (1 μ s, 0.3% DF)	90	mA	
Lead soldering time at 260°C	5	seconds	2
Operating and storage temperatures	-55°C to +100°C		

NOTES

- Derate linearity from 25°C at 1.6 mW/°C.
- From a point minimum 1/16 inch (1.6 mm) from the bottom of the lamp.

MV53124A MV54124A MV57124A MV49124A

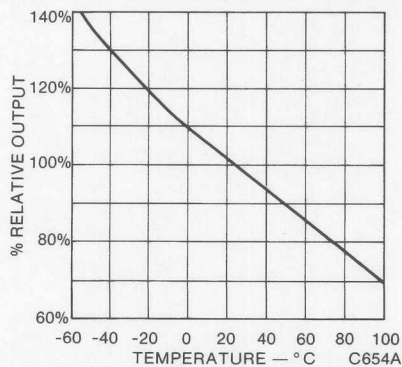
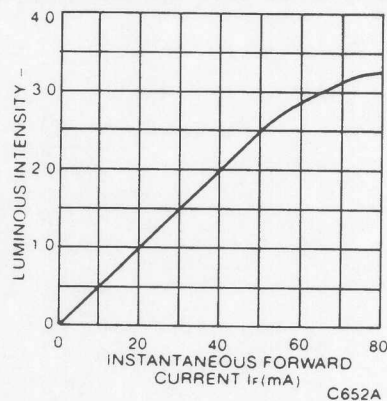
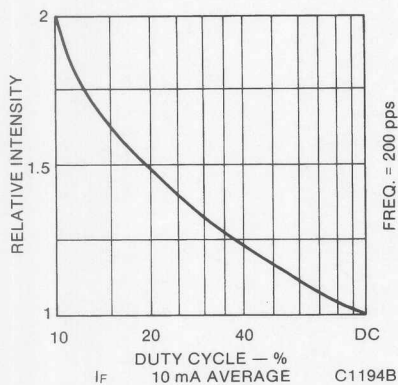
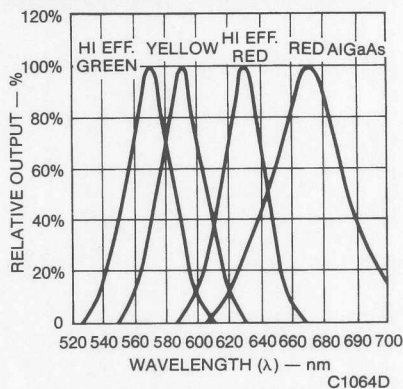
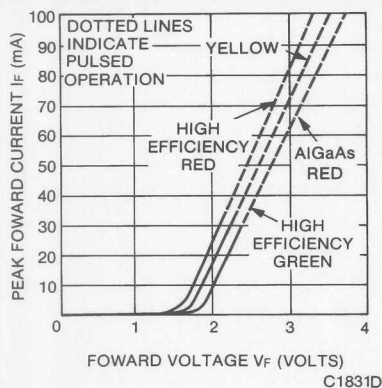
- Legend backlighting
- Panel indicator
- High quality periphery



TYPE	SOURCE COLOR	LENS EFFECT
MV53124A	Yellow	Yellow Diffused
MV53124A	High Eff. Green	Green Diffused
MV57124A	High Eff. Red	Red Diffused
MV49124A	High Eff. Green/White/Red	White Diffused

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Temperature Unless Otherwise Specified)



TYPICAL SELECTED OPTICAL CHARACTERISTIC CURVES

(25°C, 50% Relative Humidity, 1000 lux)

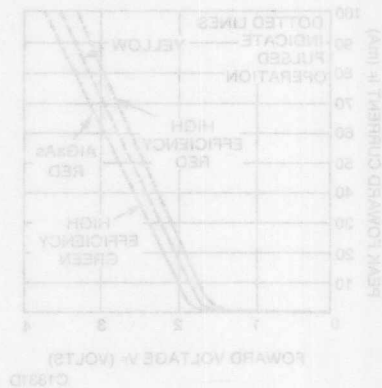


Fig. 1: Forward Current vs. Forward Voltage

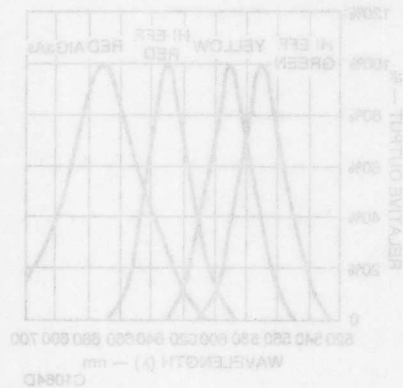


Fig. 2: Spectral Distribution

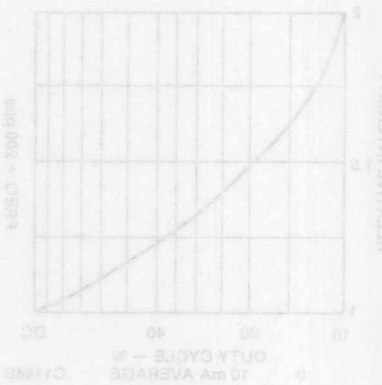


Fig. 3: Luminous Intensity vs. Duty Cycle

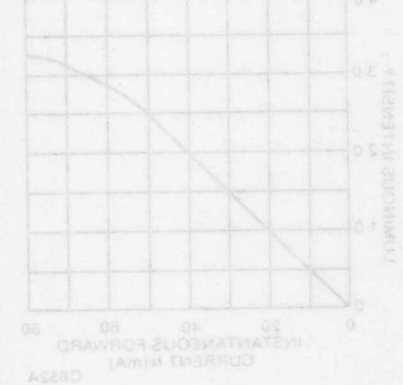


Fig. 4: Luminous Intensity vs. Forward Current

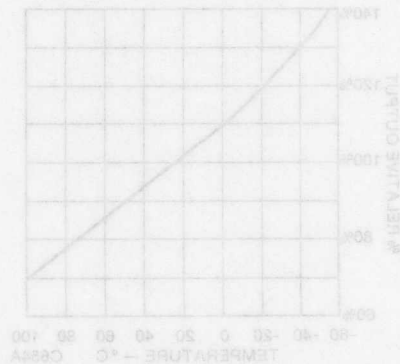
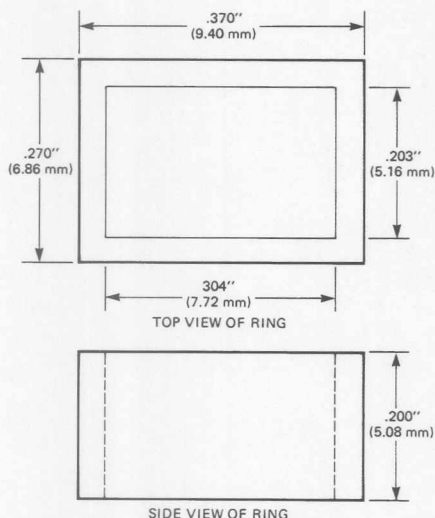
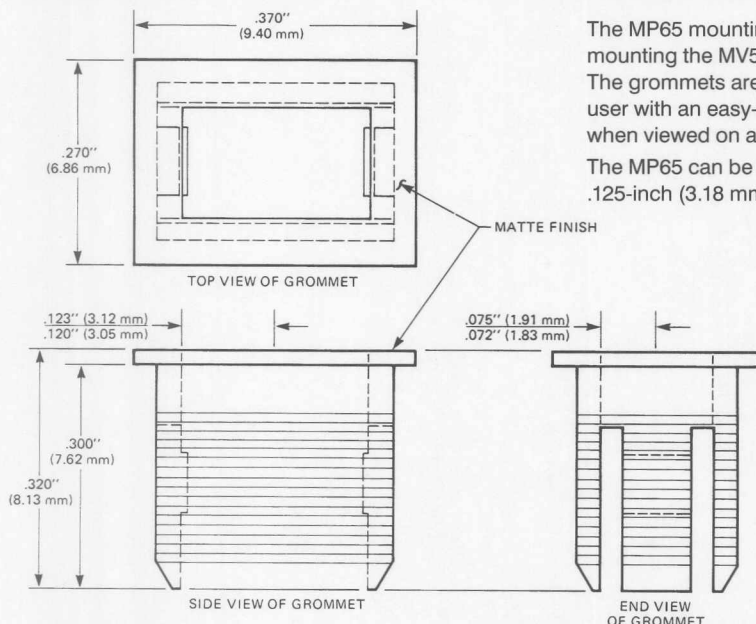


Fig. 5: Output vs. Temperature

PACKAGE DIMENSIONS



MATERIAL: POLYPROPYLENE BLACK

DESCRIPTION

The MP65 mounting grommet is intended for panel mounting the MV5X124 Series of rectangular lamps. The grommets are made of Black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP65 can be used on any panel thickness up to .125-inch (3.18 mm).

PANEL HOLE PUNCHING

Punches can be ordered from one of the following sources:

W.A. WHITNEY COMPANY
650 Race Street
Rockford, IL 61105
(815) 964-6771
(Request a 28xx series punch with dimensions of $\frac{5}{16}" \times \frac{7}{32}"$)

ROTEX PUNCH COMPANY, INC.
2350 Alvarado Street
San Leandro, CA 94577
(415) 357-3600
(Request a 3506 series punch with dimensions of $\frac{5}{16}" \times \frac{7}{32}"$)

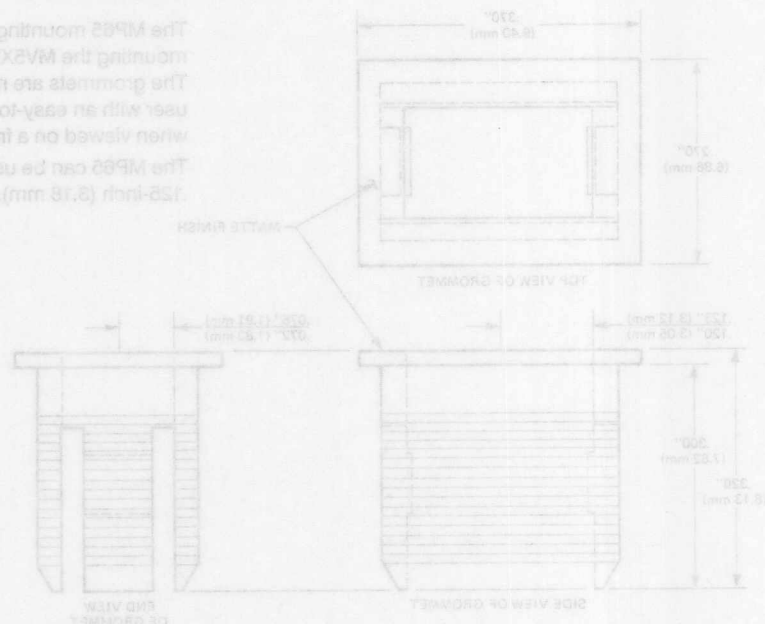
MP65

DESCRIPTION

The MP65 mounting grommet is intended for panel mounting the MV5X124 Series of rectangular lamps. The grommets are made of black plastic and provide the user with an easy-to-mount, professional appearance when viewed on a front panel.

The MP65 can be used on any panel thickness up to .125-inch (3.18 mm).

PANEL MOUNTING GROMMET

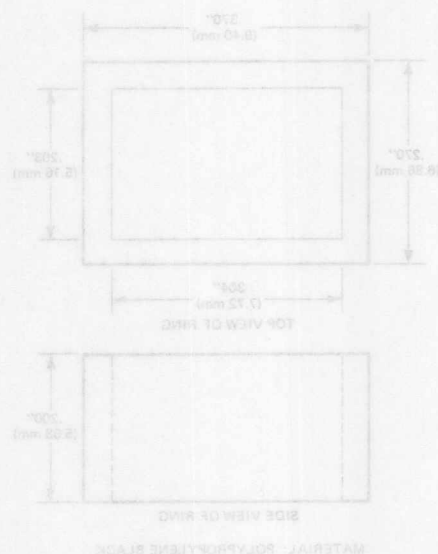


PANEL HOLE PUNCHING

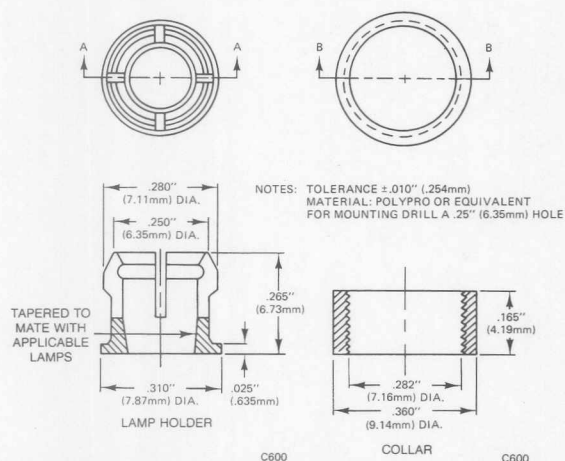
Punches can be ordered from one of the following sources:

W.A. WHITNEY COMPANY
850 Race Street
Rockford, IL 61105
(815) 884-8771
(request a 28x series punch with dimensions of 1/4" x 3/4")

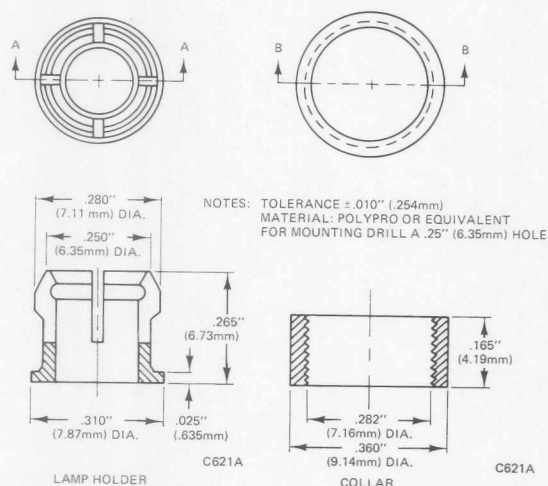
ROTEX PUNCH COMPANY, INC.
2350 Avenida Street
San Leandro, CA 94677
(415) 357-3800
(request a 2808 series punch with dimensions of 1/4" x 3/4")



PACKAGE DIMENSIONS



MP22 TWO-PIECE POP-INS FOR MV5X2XA



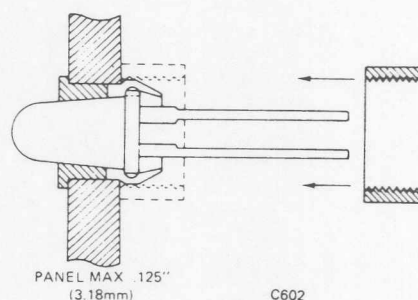
MP52 TWO-PIECE POP-INS FOR MV6X5X AND MV5X5X

DESCRIPTION

The MP Series of mounting grommets is intended for panel mounting of any standard T-1 $\frac{3}{4}$ Quality Technologies light emitting diode indicators. The grommets are made of plastic and are available in Black only.

The MP65 Series will easily mount the applicable lamps on any panel thickness up to .125-inch (3.18 mm).

TYPICAL MOUNTING TECHNIQUE FOR EITHER TYPE

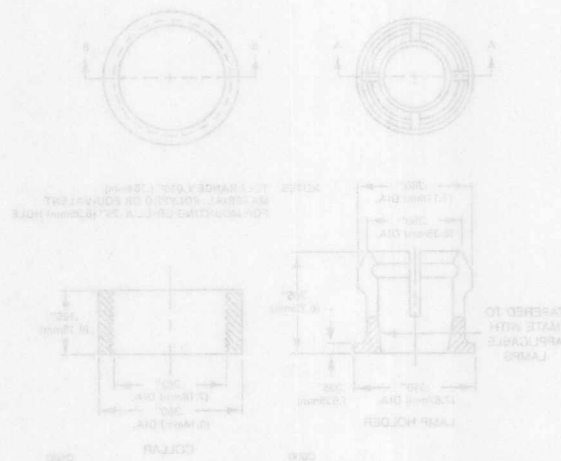


MP22 MP23

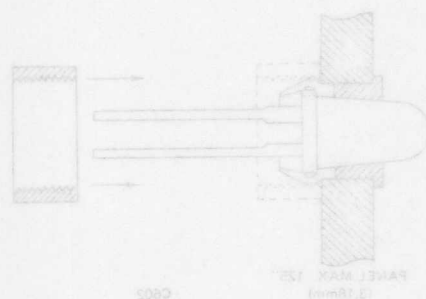
DESCRIPTION

The MP Series of mounting grommets is intended for panel mounting of any standard T-1X Quality Technologies light emitting diode indicators. The grommets are made of plastic and are available in Black only. The MP22 Series will easily mount the applicable lamps on any panel thickness up to .125-inch (3.18 mm).

PACKAGE DIMENSIONS

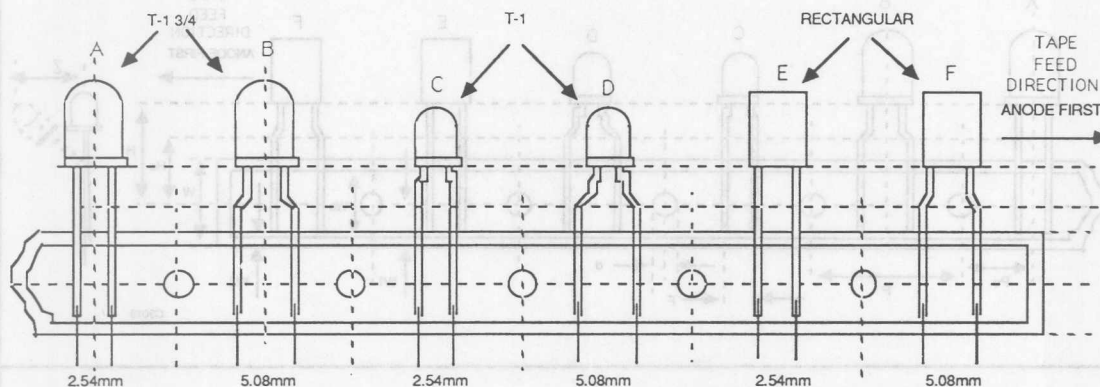


TYPICAL MOUNTING TECHNIQUE FOR FITTER TYPE



CONFIGURATIONS

CONFIGURATIONS:



FAMILY

	CONFIGURATIONS AVAILABLE	QTY PER REEL	QTY PER AMMO-PACK
T-1 3/4*	A/B	1200	1200
T-1**	C/D	2000	2000
RECT. (MV5X123)	E/F	2000	2000
RECT. (MV5X124A)	E/F	1500	1200
RECT. (HLMP-0X0X)	E/F	2000	1500

* MV5X5X, MV5X15X, MV6X53X, FLVXXX, HLMP-3XXX, MV3X50

** MV5X6XX, HLMP-1XXX

FEATURES

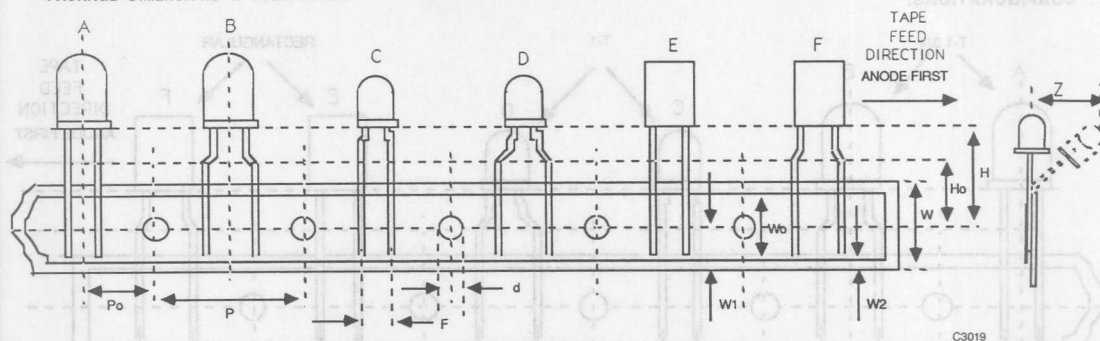
- Automatic PCB assembly of most T-1-3/4, T-1, and rectangular leds with radial insertion machines.
- Meets ANSI/EIA standard RS 468
- Standard 2.54mm (0.100") lead spacing or preformed to 5.08mm (0.200")
- Choice of a variety of "H" dimensions.
- One luminous intensity category per reel or ammpack

NOTES

- Tape & Reel is not available for MV5X (T-3/4) MV5X9XA or MV5X7X lamp families
- Anode leaves Reel first.

PACKAGE DIMENSIONS & TOLERANCES

PACKAGE DIMENSIONS & TOLERANCES:



	A	B	C	D	E	F
1	16.5	—	16.5	—	16.5	—
2	17.5	—	17.5	—	17.5	—
3	18.5	—	18.5	—	18.5	—
4	20.5	20.5	20.5	20.5	20.5	20.5
5	22.5	22.5	22.5	22.5	22.5	22.5
6	24.5	24.5	24.5	24.5	24.5	24.5
H0	—	16	—	16	—	16
F	2.54	5.08	2.54	5.08	2.54	5.08
	+0.6/-0.1					

P	12.7 ± 0.3	H₀	$\pm 0.5\text{mm}$
P₀	6.35 ± 1.0	W	$18.0 + 1.0 / - 0.5$
d	4.0 ± 0.2	W₀	15.0 ± 0.3
Z	2.0 max	W1	$9.0 + 0.75 / - 0.5$
H	$\pm 1\text{mm}$	W2	≤ 0.5

ALL DIMENSIONS IN MILLIMETERS (mm)

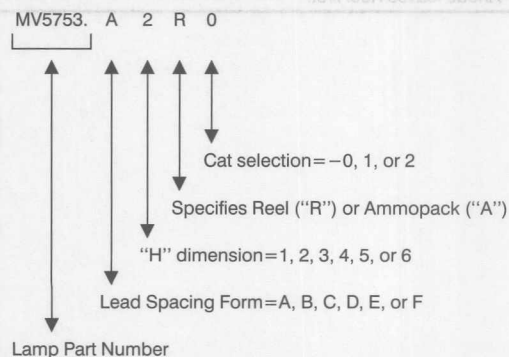
ORDERING INFORMATION

To order LED lamps packaged on Tape & Reel/Ammopack, include appropriate standard lamp part number and suffix code to specify configuration and optional features.

EXAMPLES:

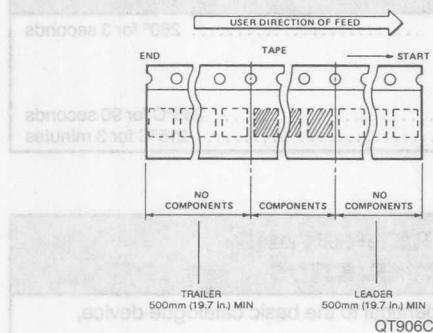
MV5753.A2R0 - This specifies MV5753 lamps with A configuration ("A") - with H2 height dimension ("2") on Tape & Reel ("R") - with no category selection ("0").

MV5753.B4A2 - This specifies MV5753 lamps - with B configuration ("B") - with H4 height dimension ("4") on tape in ammpack ("A") - with two highest yield categories ("2"), Note: but only one category per ammpack.



TAPE AND REEL SPECIFICATIONS FOR SURFACE MOUNT OPTIONS

12 mm Tape and Reel

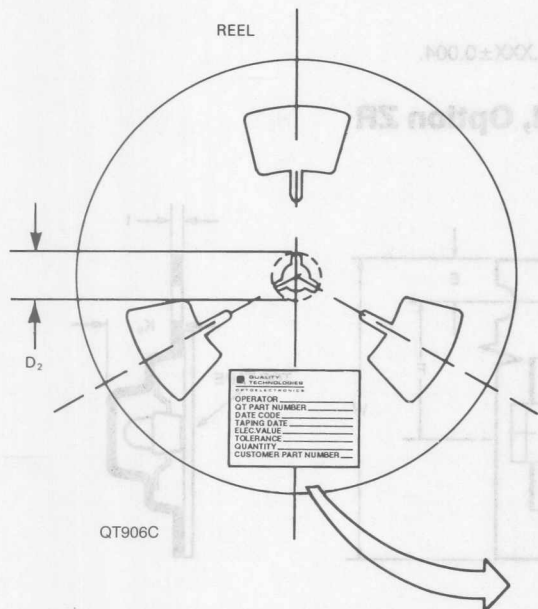
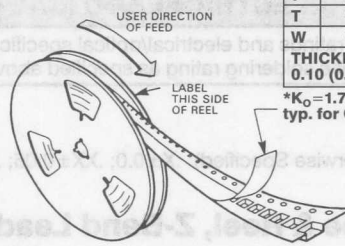


DIMENSIONS PER ANSI/EIA
STANDARD RS-481.
ALL DIMENSIONS ARE IN
MILLIMETERS (INCHES).

A	178.0 ± 2.0 (7.0 ± 0.08) DIA.
C	13.0 (0.512) DIA. TYP.
D	1.55 (0.061 ± 0.002) DIA
D ₂	20.2 (0.795) DIA. MIN.
E	1.75 ± 0.1 (0.069)
F	5.50 (0.127 ± 0.002)
K ₀	3.05 ± 0.1 (0.120) TYP.
N	50.0 (1.970) MIN.
P	4.0 (0.157) TYP.
P ₀	4.0 (0.157) TYP.
P ₂	2.0 (0.079 ± 0.002) TYP.
t	0.3 (0.012) TYP.
T	18.4 (0.72) MAX.
W	12.0 ± 0.3 (0.472 ± 0.012)

THICKNESS OF TOP COVER TAPE
0.10 (0.004) MAX.

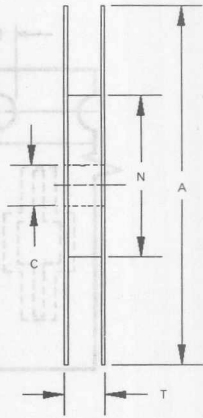
*K₀ = 1.7 ± 0.1 (0.067)
typ. for QTLP282-X



TOLERANCES (UNLESS OTHERWISE SPECIFIED):
.X ± 0.1; .XX ± 0.05 (.XXX ± 0.004)

QUALITY TECHNOLOGIES
OPTOELECTRONICS

OPERATOR _____
QT PART NUMBER _____
DATE CODE _____
TAPING DATE _____
ELEC. VALUE _____
TOLERANCE _____
QUANTITY _____
CUSTOMER PART NUMBER _____



ORDERING INFORMATION

To order MV6X00 subminiature lamps on tape and reel include appropriate standard lamp part number and suffix code to specify configuration and optional features.

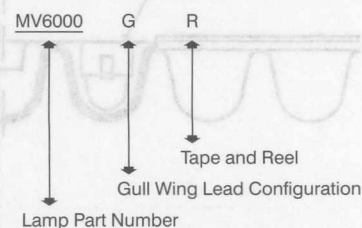
EXAMPLES:

MV6000.GR—This specifies MV6000 lamp in Gull Wing Lead configuration on tape and reel.

MV6000.GB—This specifies MV6000 lamp in Gull Wing Lead configuration in bulk packaging

Suffix options:

- GB = Gull Wing Lead, Bulk Packaging
- GR = Gull Wing Lead, Tape and Reel
- YB = Yoke Lead, Bulk Packaging
- YR = Yoke Lead, Tape and Reel



ABSOLUTE MAXIMUM SOLDER RATING

Wave soldering temperature (1.6 mm (0.063") from body)	260° for 3 seconds
Surface Mount Reflow	
Soldering:	
Convective IR	235°C for 90 seconds
Vapor phase	215°C for 3 minutes

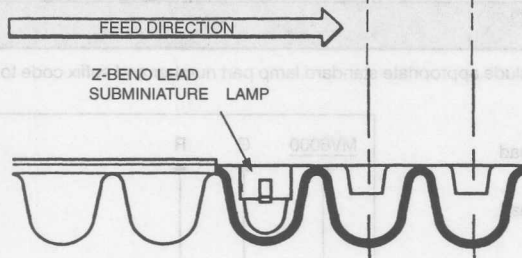
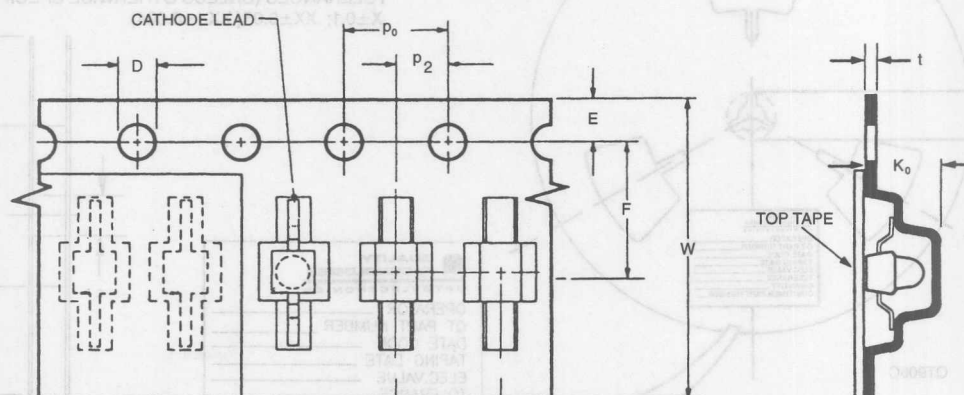
**ABSOLUTE MAXIMUM SOLDER RATINGS AND
ELECTRICAL/OPTICAL CHARACTERISTICS**

The absolute maximum ratings and electrical/optical specifications are identical to the basic catalogue device, except for the vapor phase soldering rating as specified above.

TAPING OPTIONS

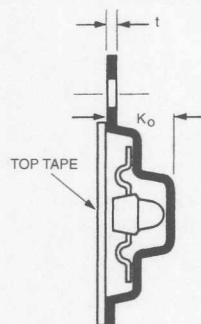
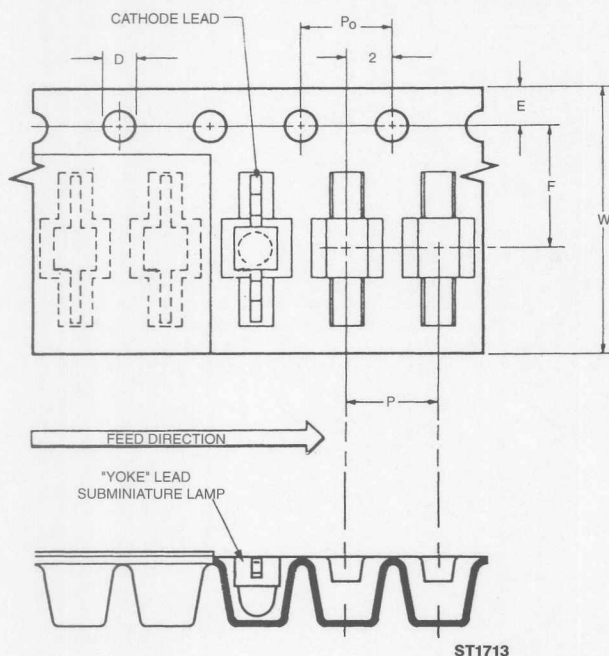
Tolerances (Unless otherwise Specified): .X $\pm$ 0.0; .XX $\pm$ 0.05; .XXX $\pm$ 0.004.

12 mm Tape & Reel, Z-Bend Lead, Option ZR

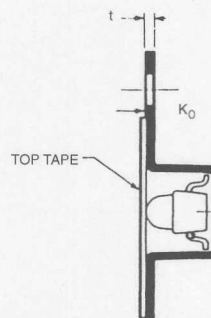
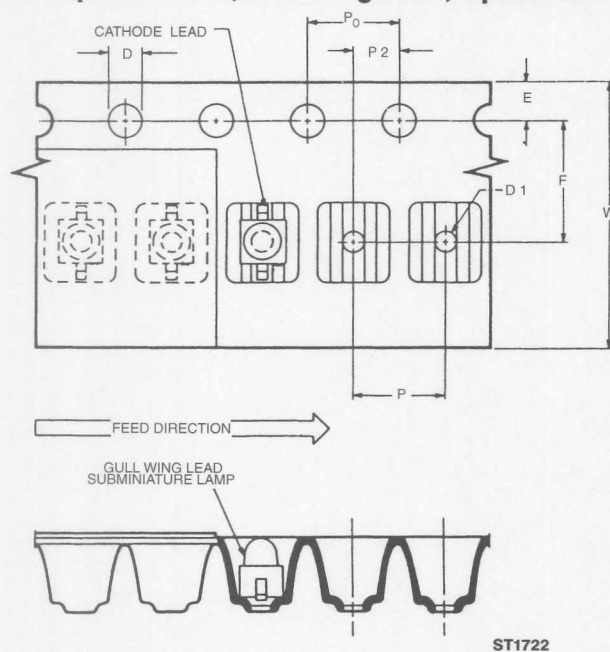


ST1742

12mm Tape & Reel, Yoke Lead, Option YR



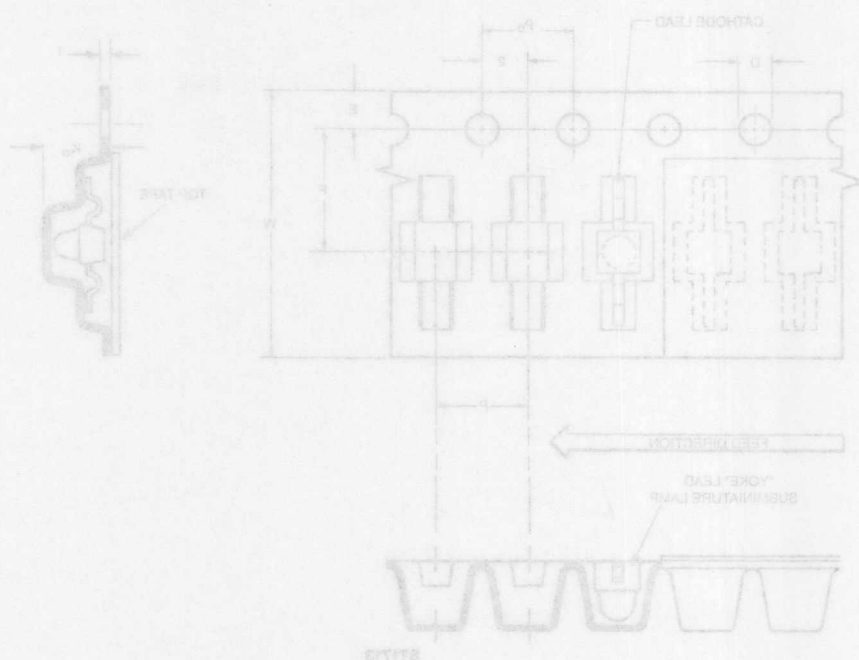
12mm Tape and Reel, Gull Wing Lead, Option GR



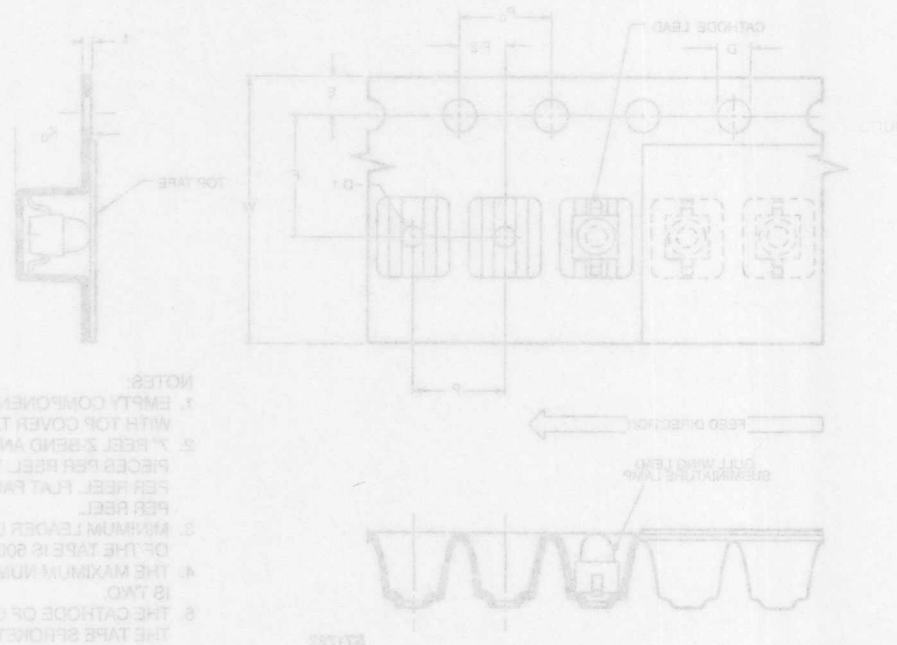
NOTES:

1. EMPTY COMPONENT POCKETS ARE SEALED WITH TOP COVER TAPE.
2. 7" REEL Z-BEND AND GULL WING; 1500 PIECES PER REEL. YOKE LEAD; 1200 PIECES PER REEL. FLAT PACKAGE; 2000 PIECES PER REEL.
3. MINIMUM LEADER LENGTH AT EITHER END OF THE TAPE IS 500 MM.
4. THE MAXIMUM NUMBER OF MISSING LAMPS IS TWO.
5. THE CATHODE OF ORIENTED TOWARDS THE TAPE SPROCKET HOLE IN ACCORDANCE WITH ANSI/EIA RS-481 SPECIFICATIONS.

12mm Tape & Reel, Yoke Lead, Option YR



12mm Tape and Reel, Gull Wing Lead, Option GR



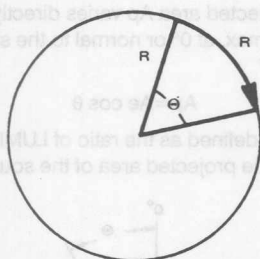
- NOTES:
1. EMPTY COMPONENT POCKETS ARE SEALED WITH TOP COVER TAPE.
 2. 7" REEL 2-BEND AND GULL WING: 1500 PIECES PER REEL; YOKES LEAD: 1500 PIECES PER REEL; FLAT PACKAGE: 2000 PIECES PER REEL.
 3. MINIMUM LEADER LENGTH AT EITHER END OF THE TAPE IS 800 MM.
 4. THE MAXIMUM NUMBER OF MISSING LAMPS IS TWO.
 5. THE CATHODE OR ORIENTED TOWARDS THE TAPE SPOCKET HOLE IN ACCORDANCE WITH ANAGIA RS-481 SPECIFICATION.

REVIEW OF GEOMETRIC PRINCIPLES

Any short discourse on the subject of photometry requires a brief review of geometric principles utilized.

RADIAN

In plane geometry the angle whose arc is equal to the radius generating it is called a radian. Therefore, if $C=2\pi R$ (Circumference of a circle) $2\pi R=360^\circ$.
Radian $=180^\circ/\pi=57.27^\circ$ (approx.).

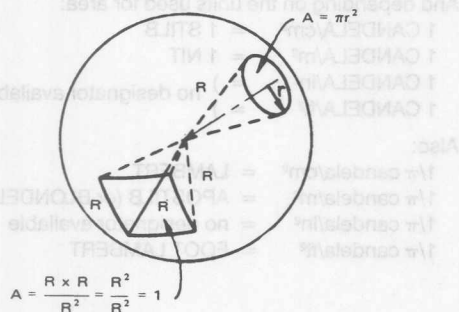


TWO DIMENSIONAL FIGURE

Fig. 1.

STERADIAN

In solid geometry one steradian is the solid angle subtended at the center of a sphere by a portion of the surface area equal to the square of the radius of the sphere. Therefore, if $AREA/R^2=1=1$ steradian and the area on the surface of a sphere equals $4\pi R^2$, then $4\pi R^2/R^2$ or 4π steradians of solid angle ω about the center of a sphere. The steradian is usually abbreviated as STER.



THREE DIMENSIONAL FIGURE

Fig. 2.

Other abbreviations of immediate concern are:

A_e =Area of emitting (or reflecting) surface.

A_p =Apparent area of an emitting source whose image is projected in space and viewed at some angle, θ .

A_d =Detection area. Whether a physical target or merely a defined spatial area, it is the area of interest.

PHOTOMETRIC TERMINOLOGY

FLUX (Symbol F)

FLUX (Symbol F)

Any radiation, whether visible or otherwise, can be expressed by a number of FLUX LINES about the source, the number being proportional to the intensity of that source. This LUMINOUS flux is expressed in LUMENS for visible radiation.

LUMINOUS EMITTANCE (Symbol L)

A source measurement parameter. It is defined as the ratio of the luminous flux emitted from a source to the area of that source, or $L=F/A_e$. Typically expressed in units of:

lumens/cm² or one PHOT,

lumens/m² or one LUX (for one METER CANDLE),

lumens/ft² or one FOOT CANDLE.

The foot candle is the more common term used in this country.

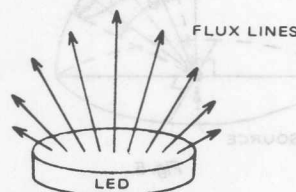


Fig. 3.

ILLUMINANCE (Symbol E)

This is a target or detector area measurement parameter. It is the ratio of flux lines incident on a surface to the area of that surface or $E=L/Ad$. Typical measurement units are the same for LUMINOUS EMITTANCE (above) i.e. lumen/cm²=one phot, lumen/m²=one lux, and lumen/ft²=one ft. candle.

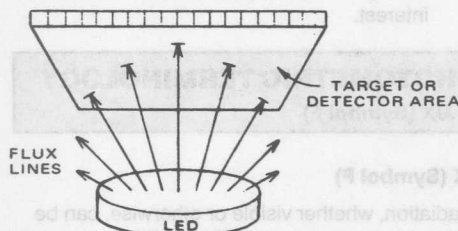


Fig. 4.

LUMINOUS INTENSITY (Symbol I)

A spatial flux density concept. It is the ratio of luminous flux of a source to the solid angle subtended by the detected area and that source. The LUMINOUS INTENSITY of a source assumes that source to be point rather than an area dimension. The LUMINOUS INTENSITY (or CANDLE POWER) of a source is measured in LUMENS/STERADIAN which is equal to one CANDELA (or loosely, one CANDLE).

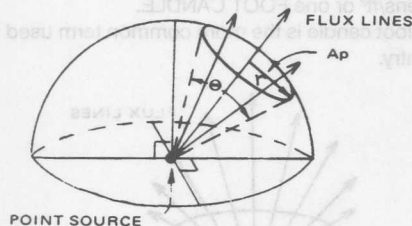


Fig. 5.

LUMINANCE (Symbol B)

Sometimes called photometric brightness (although the term brightness should not be used alone as it encompasses other physiological factors such as color, sparkle, texture, etc.) it is applied to sources of appreciable area size. Mathematically, if the area of an emitter (circular for example) has a diameter or diagonal dimension greater than 0.1 the distance to the detector,

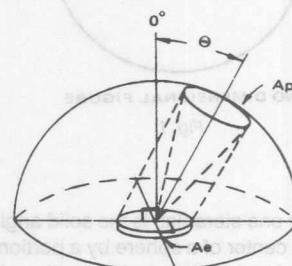
it can be considered as an area source. If less than this 10% figure, the source can be treated as point in nature. This one to ten ratio of source diameter to distance is offered as it MATHEMATICALLY very closely approximates results obtained when comparing an area source to its point equivalent. LUMINANCE presents itself as an extremely useful parameter as it applies a figure of merit to:

1. Apparent or projected area of the source (A_p).
2. Amount of luminous flux contained within the projected area of the source (A_p).
3. Solid angle the projected area generates with respect to the center of the source.

NOTE: The projected area A_p varies directly as the cosine of θ i.e. max. at 0° or normal to the surface and minimum at 90°

$$A_p = A_e \cos \theta$$

LUMINANCE is defined as the ratio of LUMINOUS INTENSITY to the projected area of the source A_p .



$$\frac{\text{LUMINOUS INTENSITY}}{A_p} = \frac{\text{LUMENS}}{A_e \cos \theta} = \frac{\text{CANDELAS}}{(\text{Sq. Unit})}$$

And depending on the units used for area:

- 1 CANDELA/cm² = 1 STILB
- 1 CANDELA/m² = 1 NIT
- 1 CANDELA/in² =) no designator available.
- 1 CANDELA/ft² =)

Also:

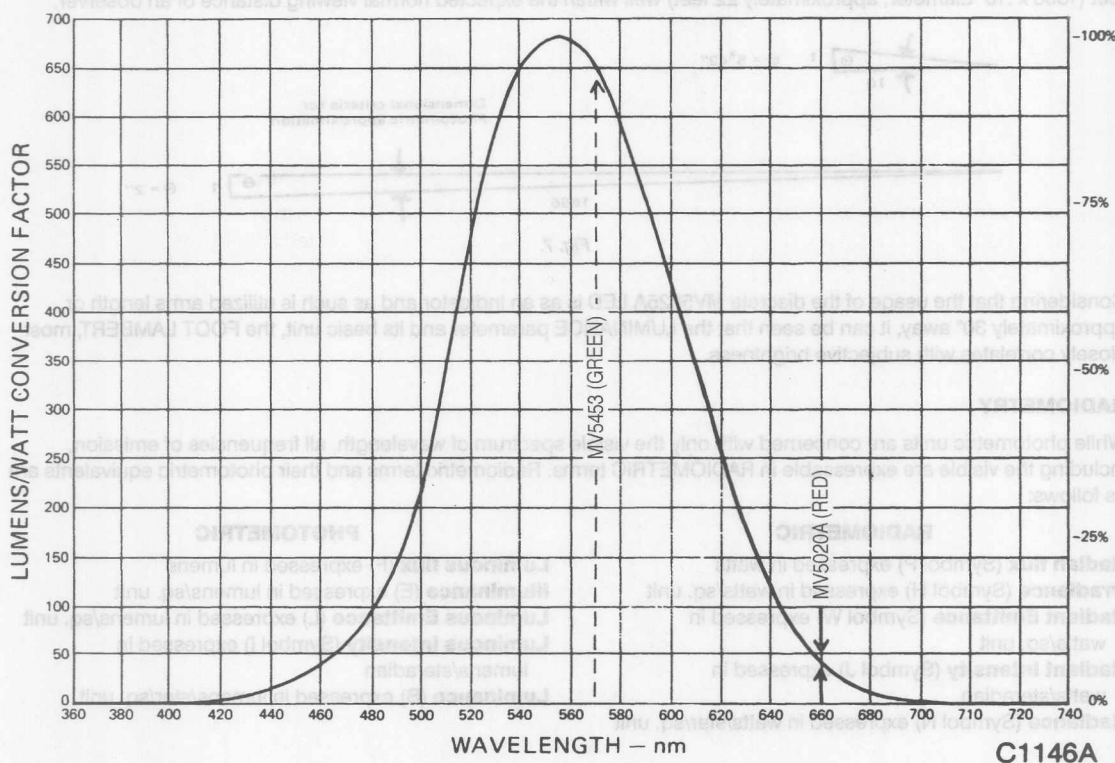
- 1/π candela/cm² = LAMBERT
- 1/π candela/m² = APOSTILB (or BLONDEL)
- 1/π candela/in² = no designator available
- 1/π candela/ft² = FOOT LAMBERT

CIE CURVE

Following is the standard observer curve or "standard eyeball" established by the Commission Internationale de l'Eclair (commonly called the CIE curve). Whereas one watt of radiated energy at any frequency corresponds to one watt of radiated energy at any other frequency, this relationship fails to hold true for photometric measurement. The CIE curve is essential therefore, not only in determining the eye's efficiency at any particular wavelength, but also the corresponding lumens per watt conversion of that particular wavelength.

For example, the MV5020A which emits 180 μ W of radiant energy at 6600Å (typical) or 41.4 lumens per watt has

$180 \times 10^{-6} \text{ watts} \times \frac{41.4 \text{ lumens}}{\text{watt}} = 7.45 \text{ mLumens}$
of flux emitted from it.



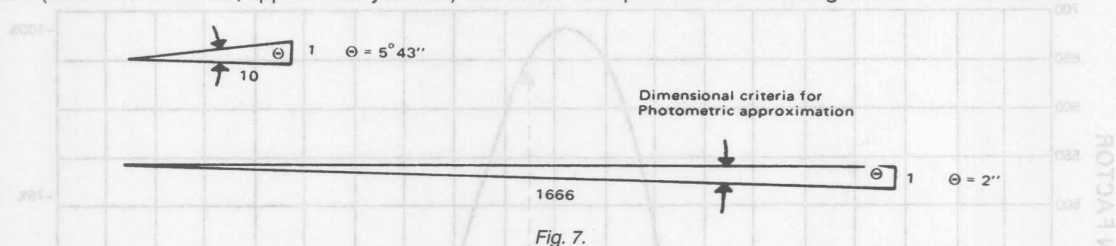
Similarly, a green emitter such as the MV5453 operating at an identical input power as the red will emit 10 μ watts of radiant energy or

$$10 \times 10^{-6} \text{ watts} \times \frac{649 \text{ lumens}}{\text{watt}} = 6.49 \text{ mLumens}$$

of flux emitted from it. In short although there exists at least an order of magnitude difference in radiant power the eyes' compensating effect "magnifies" the green to appear equally bright.

LUMINOUS INTENSITY versus LUMINANCE

The successful application of either measurement parameter as a yardstick to duplicate mathematically the visual stimulation experienced by an observer is a controversy which will probably rage for some time. As the entire electromagnetic spectrum is bounded only by the capabilities of a detector to discern it, so for within the visual spectrum the eye is the limiting factor. SUBJECTIVELY speaking, the eye can discern finer increments of arc (computed from target to eye) than a 1 to 10 relationship, or approximately $5^{\circ} 43'$. In fact, it can be shown that for view angles of much less than 2 minutes, the eye translates the source into a point and thus the photometric measurement of LUMINOUS INTENSITY (in candelas) most directly correlates with subjective brightness. For view angles of much greater than approximately 2 minutes, the eye sees the source as an area source, and thus the photometric measurement of LUMINANCE most directly correlates with subjective brightness. A two minute view angle computes to a 1/1666 ratio of source diameter to distance ratio. For the MV5025A this computes to approximately 22 feet (1666 x .16" diameter, approximately 22 feet) well within the expected normal viewing distance of an observer.



Considering that the usage of the discrete MV5025A LED is as an indicator and as such is utilized arms length or approximately 30" away, it can be seen that the LUMINANCE parameter and its basic unit, the FOOT LAMBERT, most closely correlates with subjective brightness.

RADIOMETRY

While photometric units are concerned with only the visible spectrum of wavelength, all frequencies of emission, including the visible are expressable in RADIOMETRIC terms. Radiometric terms and their photometric equivalents are as follows:

RADIOMETRIC	PHOTOMETRIC
Radian flux (Symbol P) expressed in watts	Luminous flux (F) expressed in lumens
Irradiance (Symbol H) expressed in watts/sq. unit	Illuminance (E) expressed in lumens/sq. unit
Radiant Emittance (Symbol W) expressed in watts/sq. unit	Luminous Emittance (L) expressed in lumens/sq. unit
Radiant Intensity (Symbol J) expressed in watts/steradian	Luminous Intensity (Symbol I) expressed in lumens/steradian
Radiance (Symbol N) expressed in watts/ster/sq. unit	Luminance (B) expressed in lumens/ster/sq. unit

In any manufacturing operation it is essential that the materials used in the fabrication process meet the minimum quality specifications of the device under production. To that end, prudent manufacturers establish specifications of the device under production. To that end, prudent manufacturers establish some sort of incoming quality assurance system to make sure that defective materials are culled at the door. It is equally important, however, that the screening system used in the Q.A. inspection does not reject materials which are acceptable, and that the testing procedures utilized in the system do not inadvertently damage materials which are otherwise acceptable. Unfortunately, this latter aspect of quality assurance procedures is often neglected, and whenever a device is rejected because of inappropriate testing methods, both the manufacturer and the vendor are subject to a great deal of unnecessary expense and inconvenience. Because many manufacturers who buy LED components are relatively inexperienced with the features and limitations of III-V devices, problems involving improper testing methods and unnecessary materials rejection are of particular concern to LED vendors. This note is intended to familiarize the user with the basic electrical and opto-electrical properties of LED devices and to clear up some of the problems involved in testing them.

THE MATERIAL

Historically, silicon and germanium were the first semiconductor materials to have been used for p-n junction devices such as transistors, diodes, and solar cells. However, following closely upon the invention of the germanium transistor in 1948, work was begun on predicting the semiconductivity of a material from its chemical compound. Based on energy band-gap experimentation, it was discovered that III-V materials have semiconductor properties.¹

Gallium semiconducting materials, Gallium Arsenide (GaAs), Gallium Arsenide Phosphide (GaAsP), and Gallium Phosphide (GaP) are the materials from which LED's are fabricated. These materials have the ability to emit a narrow band of monochromatic light in either the visible or infrared spectrum, depending on the constituent and ratio of ingredients. The mechanism for this emission of radiant energy is best described in terms of semiconductor Energy-Band Theory. When an external, forward-biasing voltage is applied to a p-n junction, the conduction mechanism is such that

electrons are excited by the electric field, gaining enough energy to cross the energy gap from the valence band to the conduction band, and then to relax back from the conduction band into the valence band. During the transition from the valence band to the conduction band, the electrons take energy from the field. As they pass back into the valence band, the electrons release this energy in the form of light photons. The amount of energy released is determined by the width of the energy gap. (The wavelength, or color, or the light is a function of the energy gap.) The light is emitted directly from the electrons within the depletion region formed between the two sides of the junction.

The electrical characteristics of LED's are also related to the energy gap. For example, the conduction threshold, or "knee" point on the I_f/V_f curve in the forward-biased direction occurs as approximately 1.0 volts for infrared LED's, at approximately 1.3 volts for visible red LED's, and from 1.8 to 2 volts for yellow and green LED's. The brightness of the light is directly proportional to the operating current flowing in the forward direction.

GALLIUM VS. SILICON

As a semiconductor, III-V compounds using Gallium have several advantages over silicon and germanium—reverse leakage current is several orders of magnitude lower; forward current is lower below the "knee" point; inherent thermal noise is lower; and carrier mobility is high. Perhaps the greatest advantage, certainly where LED's are concerned, is the ability to produce light directly from electron flow.

Figure 1 shows a comparison between the forward conduction characteristics of diodes formed from III-V materials and silicon. Notice that the "knee" of the conduction curve for the Gallium diodes occurs at higher voltages, and is harder than the "knee" of silicon diodes. Notice also that as the wavelength progresses from the infrared toward the blue end of the spectrum, the GaAsP "knee" points get progressively higher and the slope of the I_f/V_f curve tends to decrease. Excluding exotic devices such as Schottky or Esaki diodes, silicon diode devices normally show little difference in the forward conduction curve.

The reverse characteristics of III-V materials are similar to those of silicon except that silicon's thermal leakage

¹E.G. Bylander, *Materials for Semiconductor Functions* (New York, 1971), p. 17.

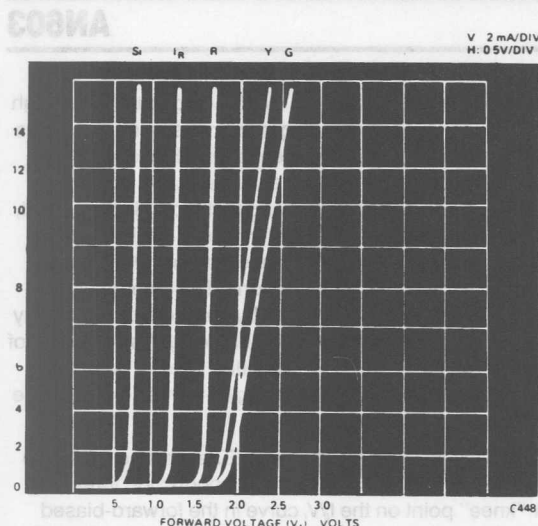


Fig. 1. Typical I/V Curves of Silicon, GaAs, and GaAsP, GaP (Silicon-IR914, IR-ME7024, Red-MV5053, Yellow-MV5353, Green-MV5253)

The reverse characteristics of III-V materials are similar to those of silicon except that silicon's thermal leakage current is higher at very low reverse voltages. The reverse breakdown voltages of silicon are typically higher, and the characteristics of silicon devices are usually controlled for reverse breakdown at particular voltages. The reverse breakdown characteristics of diodes used in LED devices are not particularly controlled, since the quality of light emission is the first priority. The MANX and MANXX series displays use LED's which have a typical reverse-mode breakdown voltage range of from 5 to 20 volts. However for guard-band purposes, the reverse voltage is specified on the data sheets at 5 volts minimum.

If a silicon device is subject to junction damage, it will often continue to perform adequately because of silicon's inherent annealing capability. When damage occurs to the junction of an LED device, however, the result is usually a softening of the "knee" or a flattening of the I/V curve. Although the device may continue to operate, performance will be less than satisfactory, and early failure may result.

DAMAGE MECHANISMS

The discussion which follows will treat, in some detail, the most common errors in LED test set-ups and will suggest either alternative testing methods or means by which improper testing methods can be corrected to produce more reliably accurate results.

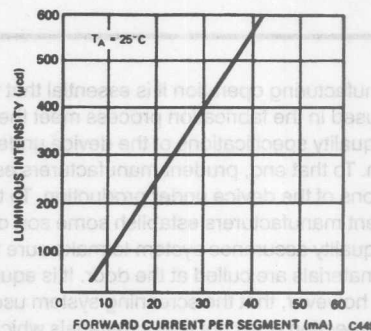


Fig. 2. Typical LED Curve Luminous Intensity vs. Forward Current for Constant Temperature

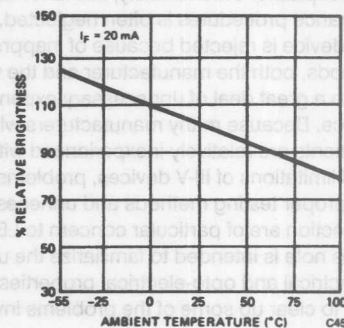


Fig. 3. Typical LED Curve Brightness vs. Temperature for Constant Current

Testing for Fabrication Defects

Thermal Shock—is a passive mode test involving a rapid refrigerate/heat cycle in which no current is applied to the device. This test is a good method for detecting weak bonds and, therefore, locating defective devices, but it should be used cautiously, especially with LED's. In LED's a 1-mil gold wire is bonded from the top of the die over to the side contact, whether it is lead frame or substrate. The wire is surrounded by the epoxy which encloses the die and forms the package. When the heat is applied, the epoxy, the gold, and the lead frame all expand at different rates. Thus, when the device is heated up too rapidly, the effects on the bond are similar to giving the wire a hard jerk. This action constitutes thermal shock and tends to weaken even good bonding and, consequently, shorten life expectancy.

Burn-In—consists of operating the device at elevated temperatures, thus accelerating the effects of operationally imposed heating. This method is frequently used in testing semiconductors, but its use is **not**

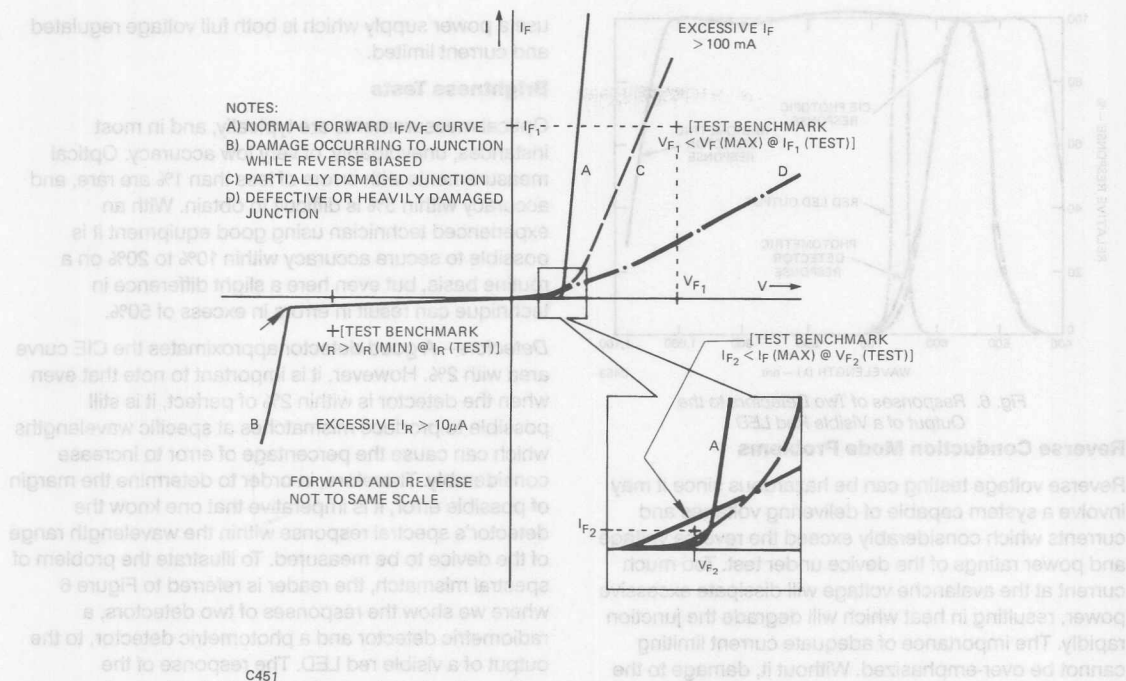


Fig. 4. Effects of Improper Testing Procedure

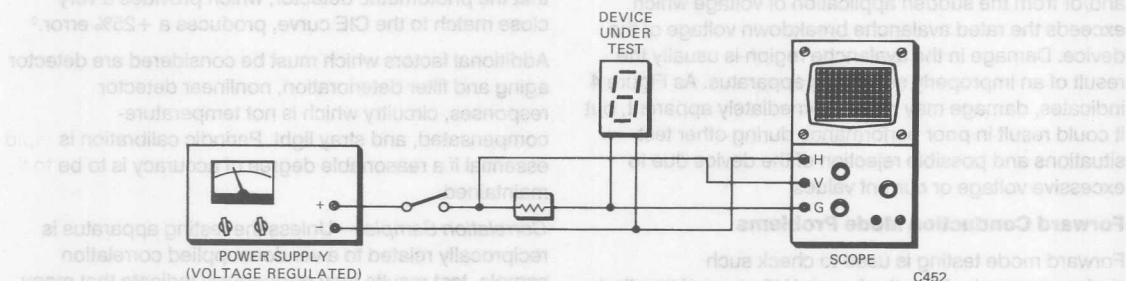


Fig. 5. Potentially Damaging Forward-Mode Test Setup

advised with LED's, especially if the testing involves operating with excess current or current which exceeds the device ratings for several hours. LED's exhibit a gradual degradation of brightness as a function of current, time, and temperature, and the higher the current, the faster the degradation. The graphs in Figures 2 and 3 illustrate typical LED responses to forward current and temperature. Exceeding the rated parameters in test can result in rapid degradation beyond an acceptable level. For the same reasons, burn-in is particularly inadvisable with LED's if the test set-up involves slow on-off cycles of overcurrent (cyclic room temperature to high temperature and then cooling).

Thermal Cycling—is an on-off cycling method which simulates operational heating effects. The device is allowed to heat up from room temperature with rated current, and is then cooled down. Thermal cycling is an excellent method for finding defective devices (poor bonds, fractures in the metalization, voids in the die-attach, etc.), and its use is recommended for testing LED's. Too often, such thermal cycling occurs in actual use, and defects are detected too late. However, to insure against exceeding the rated capabilities of a particular device, a thermal cycling test program (or operational program) should not be established without factory guidance.

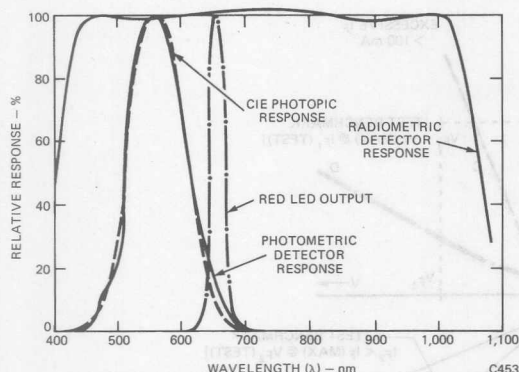


Fig. 6. Responses of Two Detectors to the Output of a Visible Red LED

Reverse Conduction Mode Problems

Reverse voltage testing can be hazardous since it may involve a system capable of delivering voltages and currents which considerably exceed the reverse voltage and power ratings of the device under test. Too much current at the avalanche voltage will dissipate excessive power, resulting in heat which will degrade the junction rapidly. The importance of adequate current limiting cannot be over-emphasized. Without it, damage to the junction can result from testing into the avalanche region and/or from the sudden application of voltage which exceeds the rated avalanche breakdown voltage of the device. Damage in the avalanche region is usually the result of an improperly set testing apparatus. As Figure 4 indicates, damage may not be immediately apparent, but it could result in poor performance during other test situations and possible rejection of the device due to excessive voltage or current values.

Forward Conduction Mode Problems

Forward mode testing is used to check such performance criteria as the forward V/I curve of the diode, brightness, ROP, and luminescence. The potential danger in examining the forward curve is damage to the diode junction, since the test circuitry can sometimes deliver very high energy bursts. For example, if a 50-volt regulated power supply is set for 5 volts to supply the test fixture, and if power is supplied through a switch as shown in Figure 5, it is possible to deliver current pulses of a high enough amplitude to result in junction damage. This problem is easily avoided by supplying low voltage power with current limiting to the test fixture. Another acceptable method, and the one which is used by General Instrument quality assurance engineers, is to

use a power supply which is both full voltage regulated and current limited.

Brightness Tests

Optical measurements are typically, and in most instances, unavoidably, of very low accuracy. Optical measurements with errors of less than 1% are rare, and accuracy within 5% is difficult to obtain. With an experienced technician using good equipment it is possible to secure accuracy within 10% to 20% on a routine basis, but even here a slight difference in technique can result in errors in excess of 50%.

Detectors—A good detector approximates the CIE curve area with 2%. However, it is important to note that even when the detector is within 2% of perfect, it is still possible to produce mismatches at specific wavelengths which can cause the percentage of error to increase considerably. Therefore, in order to determine the margin of possible error, it is imperative that one know the detector's spectral response within the wavelength range of the device to be measured. To illustrate the problem of spectral mismatch, the reader is referred to Figure 6 where we show the responses of two detectors, a radiometric detector and a photometric detector, to the output of a visible red LED. The response of the radiometric detector is about 3% high. Notice, however, that the photometric detector, which provides a very close match to the CIE curve, produces a +25% error.²

Additional factors which must be considered are detector aging and filter deterioration, nonlinear detector responses, circuitry which is not temperature-compensated, and stray light. Periodic calibration is essential if a reasonable degree of accuracy is to be maintained.

Correlation Samples—Unless the testing apparatus is reciprocally related to a vendor-supplied correlation sample, test results may erroneously indicate that many devices in a shipment do not meet the minimum brightness that was specified on the order, and could result in the rejection of devices which do meet minimum standards. Correlation samples are also essential for the correction of instrumentation drift.

Subjectivity Problems—In some instances a visual comparison may be the best method for brightness testing. However, the manner by which the human eye "sees" is affected by various factors such as the nature of the light source, viewing distance, color, texture, the observer's visual acuity, and even the viewer's emotional state. Therefore, because of these highly subjective factors involved in human visual perception, such tests alone are usually inadequate and should be

²Michael A. Zaha, "Shedding Some Needed Light on Optical Measurements," *Electronics*, November 6, 1972, pp. 94-96.

used only as a supplement to or in correlation with instrumentation. It has been our experience that manufacturers who rely solely on visual testing return many devices, a fair percentage of which can be reshipped and accepted.

Testing to Parameters Other Than Those Specified—This is a particularly important consideration when a manufacturer specifies his own parameters distinct from those normally specified. To avoid unnecessary rejection of devices, it is imperative that a device is **always tested to the parameters under which it will be expected to operate.**

SUGGESTIONS FOR PROPER TESTING

That which follows is a quick check list of "do's" which enable manufacturers to avoid many of the problems associated with running incoming quality assurance tests on LED's.

- In cooperation with the vendor, establish specifications which are economically feasible and ensure that devices are screened at their point of origin.
- Always obtain a correlation sample from the vendor before setting up the test procedure.
- Establish a reliable test procedure.
- Measure relevant parameters at relevant points.
- Make sure that the test circuitry will not erroneously indicate defects and that it will not generate failures later in the manufacturing cycle.
- Work closely with the vendor in establishing the test system.

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